Office Copy

FORTY YEARS OF FOREST RESEARCH

In The
Northern Rocky Mountain Region

Fortieth Annual Report for Calendar Year 1950

- Northern -
Rocky Mountain
Forest & Range
Experiment Station
Missoula Montana

George M. Jemison, Director

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

3 copies sent [illegible]
5-16-51

FORTY YEARS OF FOREST RESEARCH IN THE NORTHERN ROCKY MOUNTAIN REGION

Fortieth Annual Report
Northern Rocky Mountain Forest and Range Experiment Station

- 1950 -

FOREWORD

Every once in awhile it is profitable in any continuing endeavor to stop, step to one side, and take a cold, calculating look at one's self -- at the past, at the present, and as far into the future as possible. There are especially good reasons for doing so at the Northern Rocky Mountain Forest and Range Experiment Station this year. This is our fortieth anniversary and our fortieth annual report. Forty years have elapsed since organized research was started by the Forest Service in the northern Rockies.

The past 40-year period has seen two world wars, the booming '20's, the Great Depression, and now the not-so-cold war, which threatens to break out into World War III. All have had a profound effect on forestry and on problems in the management of our natural resources.

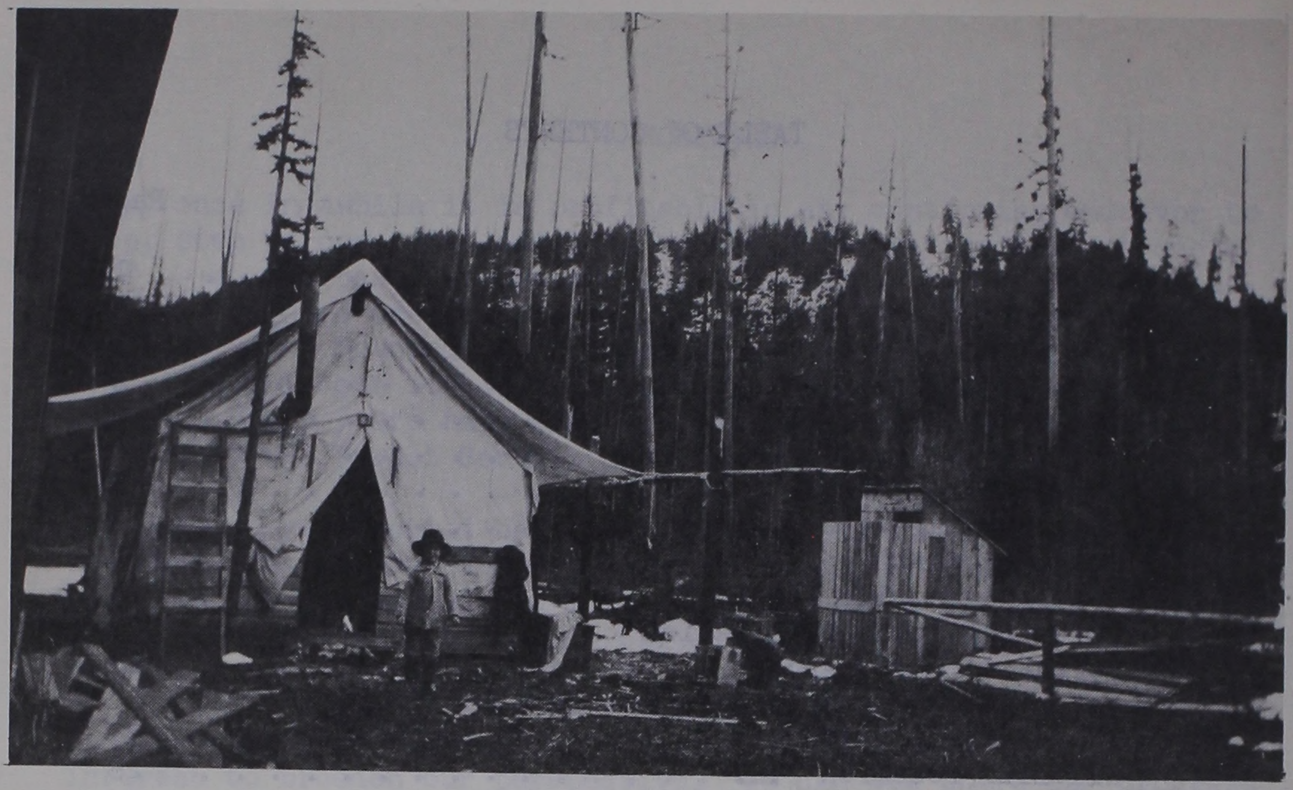
Looking back over 40 years of research we find much of historical interest to broaden our perspective. We can see where our progress has been adequate and where it has lagged. We can see the places where our program must be strengthened if we are to get at the vital problems in the production of wood, forage, and water. We believe this report on our fortieth anniversary will help orient our research program and serve as a guide for the coming years.

Time often dims a clear picture of the development of research results. The reader should remember that any progress made in the forty years and reported here is from the combined efforts of administrative and research men alike, within and outside the Forest Service organization. Acknowledgment is made with the firm belief that such progress as has been made has resulted from the understanding, the foresight, and the direct contributions of men not immediately charged with research responsibilities.

Special mention should be made here of the fine cooperation of other U. S. Department of Agriculture and U. S. Department of Interior agencies over the years. Their personnel have contributed materially to this report in the fields of forest insect investigations, forest pathology, and forest biology. Acknowledgment is made to the following men in these respective fields: James C. Evenden, Forest Insect Laboratory, Bureau of Entomology & Plant Quarantine, Coeur d'Alene, Idaho; Charles D. Leaphart, Division of Forest Pathology, Bureau of Plant Industry, Soils & Agricultural Engineering, Missoula, Montana; and Lowell Adams, Fish & Wildlife Service, Missoula, Montana.

TABLE OF CONTENTS

	Page
Introduction	1
Forty years of growth	3
The early days	3
The second ten years	4
The busy 1930's	5
The fourth decade, 1941-1950	6
Forty years of progress	7
Forest management research	8
Range research	12
Forest economics research	16
Forest products utilization	19
Forest fire research	22
Water resource management research and flood control surveys	27
Wildlife research	28
Forest insect research	29
Forest pathology research	30
A look ahead	31
Timber production	32
Utilization	34
Forage production	36
Managing the water resource	37
Animals and the forest	40
Protecting the forest	40
Basic resource data	43
Appendix	44
Research centers and experimental forests and ranges	45
Calendar of significant dates	46
Station directors	48
Number of publications	48
Major accomplishments during 1950	49
Publications issued during 1950	58
Station personnel, December 31, 1950	67
Finances	69



THEN--First camp at the Priest River Experiment Station, 1911

NOW--The modern Priest River office and laboratory, 1950

INTRODUCTION

A tired team turned with the wagonload of equipment off the old stage road that wound among the stumps on the new Jurgen's cutting 15 miles, as the crow flies, north of Priest River, Idaho. Into the timber ahead it plodded, on to a clearing in the 50-year-old white pine. Gear was unloaded and a tent was soon pitched. Thus was established the first camp at what is now the Priest River Experimental Forest. It was August 28, 1911 -- the beginning of organized research in the northern Rocky Mountain region. Raphael Zon and a party of 10 men worked hard that fall clearing land, erecting an office-laboratory building, and putting in improvements. By the end of October most of the essential work was finished and two men were left to begin the serious work of establishing a research program.

The two men assigned to research had little with which to work in those days except their hands and their heads. But they had vision and fortitude. They also had the backing of the "District" men in Missoula, who were responsible for protecting and administering the national forests. These men believed that research could help them solve their problems and they had confidence in their decision to support an organized investigative program.

The memory of 1910 was still fresh in the minds of all the Forest Service men. They had witnessed $3\frac{1}{2}$ million acres blackened by fire in northern Idaho and western Montana the year before, one of the worst catastrophies ever to hit a forested region. They thought of the thousands of acres now in need of replanting and how little they knew of the mysteries of seed production, germination, and seedling survival; of the cheap and efficient production of good planting stock in tree nurseries; of the methods for planting young trees so they would live and grow; and of getting the right species planted on each site.

The lumber industry was booming and calls for national forest stumpage were heavy. But how best to harvest merchantable timber and leave cutovers in the best shape to regenerate and grow was not too well known. The need for information was felt all the way from the white pine saw-timber forests of northern Idaho and the larch-fir and ponderosa pine of western Montana to the lodgepole pine of the Continental Divide region where mine props, posts, ties, and other small products were in demand. How should these stands be cut? What marking rules should be followed? These were pertinent questions in 1911.

Grazing problems were in the forefront too, at that early date. In 1911 the average annual loss from poisonous plants on the Madison Forest alone was calculated at 1,000 sheep and 250 cattle. Large sections of range were unused because of concentrations of poisonous

plants. What was the grazing capacity of the range? Many grazing administrators wished they knew. In some places the tendency was to be conservative and understock the range. In others, more liberal attitudes resulted in too heavy use by sheep and cattle. But how could grazing capacity be determined?

Three transcontinental railroads had been built through the region, one only five years before. Huge quantities of ties, poles, and timbers used for maintenance focused attention on the need for wood preservatives to lengthen the life of such essential wood products. Service tests on treated ties and poles were badly needed. The lumber industry too was questioning Forest Service practices that required utilization of small and partially defective logs. But who knew what was the marginal log or tree? Which ones would not pay their way through the mill? Cost data and lumber grade recovery information were almost completely lacking.

Insect and disease problems were pressing. Destructive outbreaks of bark beetles were drawing attention in different sections of the country and tree diseases were all too common. Much had to be learned about the life histories of insects and fungi and of effective control methods.

The crew which established the Priest River Experiment Station in 1911.

Forest Service men were aware, even at this early date, that water was an important factor in land management. But many considered only the relation of forest practices to erosion. In 1915 the investigative committee reported, "This District's part in the study of erosion has been completed, since the Supervisors reported practically no erosion on the Forests of the District." The opening up of isolated forests, more intensive utilization, and generally greater development of the region's resources were to change the entire aspect of water resource management.

This report of 40 years of progress at the Northern Rocky Mountain Forest and Range Experiment Station would not serve much purpose if it were an historical account alone. The following pages, therefore, include not only a summary of 40 years of station growth and station contributions to knowledge, but also a look ahead. With the perspective of 40 years and an understanding of major trends we should profit by this effort to analyze again the problems that confront us. Such an effort is not new but we hope it serves as one guide on the road ahead.

FORTY YEARS OF GROWTH

The Early Days

When Raphael Zon, R. Y. Stuart, and F. I. Rockwell chose the Priest River experimental area in 1911, it became the third forest research center to be established in the United States. In 1908 the Fort Valley Experiment Station had been located at Flagstaff, Arizona, and one year later the Fremont Station came to Colorado Springs, Colorado. The Priest River area was selected because it was in the climatic region that embraced the western white pine forest type. At that time, the other primary commercial types -- ponderosa pine, lodgepole pine, and Douglas-fir -- were to be served chiefly by the Fort Valley and Fremont Stations and by the Wind River Station, planned but not yet established in the State of Washington.

From 1911 to 1918 research at Priest River was primarily silvicultural and under the administrative supervision of the Office of Silviculture (the forerunner of today's Division of Timber Management in the Regional Office). Substantial investigations in other fields were underway, however, throughout the region. The Grazing Office was handling range studies; the Forest Products Office was working on a variety of projects including timber service tests, mill scale studies, and logging studies; the Office of Operation handled fire studies, and from 1914 to 1921 responsibility for planting studies was centered at the Savenac Nursery at Haugan, Montana. In 1918 silvicultural research, which had been the main line of endeavor at Priest River, was placed under direct supervision of the Director of Research, Washington, D. C.

Donald R. Brewster was the first station director (1911-1917). During

these early years men and money were scarce. Few buildings, roads, trails, or telephone lines had been built or little research equipment purchased. In 1911 only ten items of property showed on the inventory. Funds appropriated for the Priest River Station varied from about $5,000 to $10,000 per year, 1911 through 1920. The technical staff consisted of two men during most of this period, although a "ranger" was employed to handle the improvement and maintenance work and fire protection. In spite of the handicaps of few men and little money, the physical plant was developed rapidly during the first decade. Dwellings, office, greenhouse, roads, and other improvements were built. A substantial research program was initiated.

As would be expected, World War I was a period of retrenchment. The staff was reduced to one man, J. A. Larsen, who became the second director of the station in 1918. He worked alone from 1917 to 1920.

Active interest in forest insect control had begun in 1908 in the region when the Bureau of Entomology appointed a temporary agent at Columbia Falls, Montana. A permanent appointee was located in Missoula in 1912 and two entomological rangers were added by the end of 1914. This station was closed in 1917. After the war, in June 1919, James C. Evenden opened the Forest Insect Laboratory in Coeur d'Alene, Idaho.

The first pathological work began in the region in 1911 when James R. Weir came to Missoula to begin studies of the heart rots of commercial timber species. The pathological laboratory was moved to Spokane, Washington, in 1919.

The Second Ten Years

In 1921 the station program was revitalized. Headquarters were moved from Priest River to Missoula and R. H. Weidman became the director. The move of station headquarters to Missoula necessitated a change in the name "Priest River Experiment Station." After much discussion the name "Northern Rocky Mountain Forest Experiment Station" was adopted, probably in 1925, although the record is not clear on this point. The present name "Northern Rocky Mountain Forest and Range Experiment Station" was made official in 1931.

During the second decade of the station's life, finances fluctuated between $13,000 and $20,000 per year, about double the allotments of the previous 10-year period. The technical staff varied from three to five. With the passage of the McSweeney-McNary Forest Research Act in 1928, which authorized establishment of regional forest experiment stations, considerable hope was held for a greatly increased research program. It was not until three years later, however, that the major change in station organization and financing came about.

The activities of the Forest Insect Laboratory increased during the decade as the staff was gradually increased. The forest pathology work terminated, however, in 1921 when the pathologist left the region. It was to be 27 years before the Division of Forest Pathology

could reestablish an active tree disease study program in the northern Rocky Mountains.

The Busy 1930's

No period in the station's history saw as many changes as the decade 1931-1940. Prior to July 1, 1931, the activities of the station were confined almost entirely to white pine management and fire research. On this date and as a result of the McSweeney-McNary Forest Research Act, forest products research and grazing investigations were transferred to the station from the administrative offices in the Missoula regional headquarters. The forest survey was instituted and fire and range management research were expanded. These additions brought the total annual budget for 1931-1932 up to $74,000. The technical staff was enlarged from 4 to 14 workers.

Several experimental forests and ranges were formally established during this decade and added to the Priest River and Bernice Experimental Forests which had been previously set aside. The Deception Creek Experimental Forest was established in June 1933 and the Coram Experimental Forest in July 1933. Two experimental ranges were included during the period -- the Vigilante Experimental Range in July 1935, and

---

Dwellings and office of the Deception Creek Experimental Forest, Coeur d'Alene National Forest, Idaho.

one created by agreement from lands of the United States Range Livestock Experiment Station near Miles City, Montana, in 1931. The Piquett Creek Experimental Forest was set aside in 1939.

But most outstanding of all during the 1930's was the effect on research development of the various emergency work programs brought on by the depression. With the Civilian Conservations Corps came roads, trails, buildings, and other improvements on experimental forests at a rate and to an extent never before thought possible. Hazardous snag areas were eliminated, ranges were reseeded, and timber stands were thinned and put in shape for management studies. Plots were installed, others remeasured, and a variety of research tasks were implemented. Other emergency programs, such as W.P.A. and E.R.A., aided rapid development of research programs, the analysis of data, and reporting of results. The expenditure by the station of $20,000 to $140,000 per year of emergency funds between 1933 and 1939 resulted in tremendously valuable physical research developments and outstanding progress in completed investigations.

The 1930's saw three different men successively take over direction of the station. Lyle F. Watts came in 1931 to be succeeded in 1936 by Stephen N. Wyckoff. Melvin Bradner became director in 1939, the sixth station head.

The Fourth Decade, 1941-1950

The happenings of the past 10 years, freshest in our minds, typify what we are prone to call "emergencies," but which seem more and more to be the normal pattern of events. At the beginning of the decade, with emergency work programs of depression days behind, the station staff was reduced. Annual appropriations averaged about $105,000 or about half the record high of a few years earlier.

World War II caused a further reduction in funds and a sharp shift in the research program. The war brought a number of special jobs to the station, particularly in the products and forest resource survey fields. These jobs lasted through 1947. The station is proud of its World War II record and of its members who served with the military forces. In 1942, the first of the war years, 30 percent of regular personnel entered the Service. Twelve were in uniform by 1943. In 1944 only 13 technical men were at the station, the lowest staff size since 1930.

Reconversion to peacetime activities began in 1945 with the resumption of schedules on long time projects and the initiation of new studies. The application of forest products research results, always primarily handled by the Forest Products Laboratory at Madison, Wisconsin, was given a boost by the estabishment of a Forest Utilization Service. This service brought the results of products research directly to the wood users and processors in the region.

Substantial increases in allotments, beginning in 1946, resulted in

expanded timber and range research. The station territory was subdivided into "research centers" for the purpose of getting investigative programs closer to the ground. The Upper Columbia Center (western Montana) and the Inland Empire Center (northeastern Washington and northern Idaho) were staffed. Work in the Upper Missouri (central Montana) and Northern Great Plains (eastern Montana) Research Centers was continued on a minimum basis. The first direct allotment for forest economics research enabled us to start a small project in this field in 1947. In 1948 a flood control survey unit was established at the station with responsibility for surveys in the headwaters of parts of the Missouri and Columbia Rivers.

The programs of cooperating bureaus were stepped up too during the 1940's. The Fish & Wildlife Service opened an office at the station, staffed by a forest biologist. The Division of Forest Pathology reestablished its active cooperative relations by assigning personnel to work on the white pine pole blight problem in 1948. The staff of the Forest Insect Laboratory was increased to seven permanent men. All three divisions are active cooperators of the station at the end of this decade.

The period brought two new directors -- Charles L. Tebbe in 1946 and George M. Jemison in 1950.

As 1950 ends we are again confronted with the possibility of a third world war and the uncertainties that affect our plans and programs. Retrenchment is already under way. Conversion to war projects has started. Some personnel changes have been necessary and others are anticipated as a direct or indirect effect of the rearming effort our country is making.

FORTY YEARS OF PROGRESS

When one looks back over 40 years at the Northern Rocky Mountain Forest and Range Experiment Station, he is impressed not only with the major tangible accomplishments such as a bulletin on white pine management or a fire danger rating system, but also with the countless small contributions that were important only for a fleeting moment, so to speak. Take the development of the $1.50 wind gage, made out of pipe and galvanized iron, for example. A lot of work went into this device for measuring wind velocity at fire danger stations, and it was used only one or two years. But its development interested others in better low-cost anemometers, and it helped pave the way for future development of cheap, useful instruments that now are commonplace. No report of limited length can do justice to the many small accomplishments and to the work of the many men who labored so fruitfully over the past 40 years. This report attempts to summarize in high-light fashion what has been accomplished. Since it is a report of the station, the valuable contributions of administrative men who carried much of the load in the early years have to a great extent been omitted. The productive work of cooperating

federal research organizations is included for the sake of completeness.

Forest Management Research

The early recognition of the importance of the western white pine type, evidenced by the establishment of the Priest River Experiment Station in 1911, has profoundly influenced the direction of silvicultural and other forest management research throughout the whole life of the Northern Rocky Mountain Forest and Range Experiment Station up to the present. A great majority of the station's important research contributions have dealt with western white pine and associated species. Increasing demand for timber of other species, especially during and since World War II, has caused a broadening of the station's program to take in other forest types, but there has been no substantial letdown in attention to white pine.

Reforestation

Despite recognition that study of western white pine management was the chief responsibility of the new experiment station, reforestation research took precedence during the earliest years. The $3\frac{1}{2}$ million acres which the 1910 fires had denuded in Idaho and Montana demanded first attention. Collection, extraction, and storage of western tree seed; nursery production of planting stock; and reforestation practices were virtually unknown arts in the western United States. Aside from the custodial responsibilities of salvaging fire-killed timber and preventing more fires, the main job of the Forest Service at that time appeared to be restoration of forest cover to the burned-off mountains. Consequently, the station and other units of the Forest Service in the Northern Region immediately began seed, nursery, tree planting, and direct seeding experiments and pursued them vigorously for years.

By the end of the first five years of study, reforestation practices had been well adapted to northern Rocky Mountain conditions. Methods of seed collection, extraction, testing, sowing, and planting had been worked out. Many of these standards, developed before 1916, are still generally accepted and used today, such as age and class of planting stock required on good and poor sites.

The first experiment started at Priest River was significant in more ways than one. It was a source-of-seed study, in which the seed from many localities throughout the range of ponderosa pine was planted in one set of study plots. Now 40 years old, the trees on these plots show vividly the necessity of proper seed source selection. The failure of pines from some distant seed sources and the success of others were instrumental in the early adoption of an excellent policy requiring local seed collection for plantings in the Northern Region.

Direct seeding has always intrigued foresters looking for a cheap

A forestation experiment started at Priest River Experimental Forest in 1911 which demonstrated the existence of geographic racial differences in ponderosa pine.

Upper picture: Trees from Kaniksu National Forest, Idaho, which have grown well in their native locality.

Lower picture: Trees from Coconino National Forest, Arizona, which are slow growing and of poor form because they are not adapted to the climate of northern Idaho.

Photographs made in 1935.

---

substitute for planting because it is "Nature's way." A few successes and many failures mark the history of direct seeding in the region. We have learned, however, that direct seeding requires rodent control, proper site selection, and favorable weather for success. The last of these three elements, being beyond our control, still leaves direct seeding a chancey supplement but not a substitute for tree planting.

The White Pine Type

Several phases of the early reforestation project led into studies of seed production, germination, establishment of seedlings in relation to environment, and the climatic requirements of species. Consequently, the collection of information on ecological factors influencing the natural regeneration of species in the white pine type began soon after the station was started. Research on silvical requirements, although unspectacular, provides basic information for many silvicultural operations, particularly the regeneration of a chosen species in adequate numbers.

Silvical studies were continuous over the years, and at least 25 substantial papers and a great many more preliminary and minor reports were published. Active work was concluded for the white pine type

with two major publications: "Factors Controlling Initial Establishment of Western White Pine and Associated Species," Yale School of Forestry Bulletin 41, 1936, and "Natural Regeneration in the Western White Pine Type," U.S.D.A. Technical Bulletin 767, 1941.

Major efforts to bridge the gap between silvical studies and practical harvest cutting operations began with establishment of Deception Creek Experimental Forest in 1933. The Priest River Experimental Forest contained chiefly immature timber which was not attractive to the white pine lumber manufacturers. Deception Creek, on the other hand, contained a fine stand of mature white pine located near the center of large logging operations on the Coeur d'Alene National Forest. An intensive program of silvicultural studies and large-scale pilot plant tests was immediately started on the new experimental forest. Closely spaced permanent utilization roads were constructed with which it was possible to demonstrate for the first time that light salvage cuttings in white pine were feasible. Subsequently the practice has been widely accepted on the national forests and by some private land owners both in the white pine and other types. Probably it is the greatest contribution of the Deception Creek Experimental Forest, although it has received little recognition as a product of research. The experimental forest has also been made a center for large-scale demonstrations of stand improvement measures in both cut-over and natural stands; for rehabilitation of culled-over stands by burning and planting or seeding; and for various timber marking practices.

White pine blister rust became established in Idaho in 1923, but did not become widely conspicuous until almost 1940. Most early control efforts centered on physical destruction of the alternate host plant, ribes. Later it became evident that silvicultural measures which would impede or prevent growth of ribes offered attractive possibilities for greatly lightening the direct control project. Silvicultural control includes such measures as burning to destroy ribes seed and plants, and partial shade to prevent establishment and growth of new plants. "Blister Rust Control in the Management of Western White Pine," Station Paper 3, 1941, prepared in cooperation with the Bureau of Entomology and Plant Quarantine, and "Marking Instructions for the White Pine Type in the Northern Rocky Mountain Region," 1947, have summarized recommendations for silvicultural ribes control. Additional possibilities for control by silvicultural means have been suggested and the subject is still being actively studied.

Another and more mysterious ailment called "pole blight" has been discovered in white pine. The Forest Service is studying pole blight in collaboration with the Bureau of Plant Industry, Soils, & Agricultural Engineering, the University of Idaho, and other organizations. The station is currently investigating pole blight control through methods of cutting.

Although a thinning experiment was started at Priest River in 1914, very little attention was given to studies in the management of young or intermediate stands during the first 15 years. Subsequent stand

improvement investigations, concentrated in the white pine type, supplied the basis for extensive pruning, weeding, release cutting, and sanitation programs during the CCC days. More recently, opportunities for stand improvement by means of sale area betterment funds collected under the Knutson-Vandenberg Act have created a fresh demand for more information. As a consequence, the station prepared a timber stand improvement manual which was adopted by the Northern Region of the Forest Service in 1949. Stand improvement studies are still continuing.

The need for tree volume tables to aid in timber cruising and for yield tables with which to predict growth for management plans was felt as soon as the national forests became actively engaged in the timber business. This was particularly true in the white pine type where the larger share of the logging and greater part of the values were concentrated. At about the time reforestation research culminated in 1916, forest mensuration investigation began in earnest. Construction of tree volume tables and yield tables commanded major attention until about 1930. By that time, volume tables suited to the utilization practices of the region for all important species and normal yield tables for the white pine type had been completed. The yield tables and several of the volume tables were published in U.S.D.A. Technical Bulletin 323, "Second-Growth Yield, Stand, and Volume Tables for the Western White Pine Type," 1932. From 1931 to 1941, many additional volume, yield, and site classification tables were prepared by the Forest Survey as part of the job of resource inventory. Growth in selectively cut stands and growth in non-normally stocked stands have more recently appeared as problems of great importance to forest managers. The station is working on them, but to date the problems have been only partially solved.

Other Forest Types

From 1906 to 1920, lodgepole pine was cut heavily in central Montana for smelter converter poles, mine props, fence posts, fence and corral poles, and domestic fuel. During this period the Forest Service tested and developed methods of commercial thinning, selective cutting, and slash disposal which satisfactorily met the needs of the times. Then lodgepole pine fell into a long period of disuse which lasted until transmission pole and pulpwood markets appeared during World War II. In 1945 a new phase of research began which has taken into account the results of the old cuttings, the changed logging methods, and new utilization standards. Currently, studies of cutting, regeneration, and slash disposal are being conducted on only a modest scale.

The ponderosa pine type extends across the work areas of all western regional forest experiment stations. This station has always collaborated with other western experiment stations in ponderosa pine research but only in recent years have we taken a leading part in ponderosa pine management studies. Outstanding evidence of accomplishments include U.S.D.A. Technical Bulletin 511, "Timber Growing

and Logging Practices in Ponderosa Pine in the Northwest," 1936, and University of Montana Bulletin 339, "Application of Selective Logging to a Ponderosa Pine Operation in Western Montana," 1934. The station also contributed heavily to the data in the interregional U.S.D.A. Technical Bulletin 630, "Yield of Even-Aged Stands of Ponderosa Pine," 1938. Under the post-World War II impetus given by the research center program to localized application of research, ponderosa pine management problems have been investigated intensively in the Upper Columbia and Inland Empire Research Centers.

The western larch--Douglas-fir type, like the lodgepole pine type, has felt the increased national demands for timber products of World War II and the post-war period, and silvicultural research has been started in this important type. To date, information on growth and mortality determined from surveys of old cuttings, and a preliminary tree vigor classification have been published. Natural regeneration studies were started on the Kootenai National Forest and the Coram Experimental Forest in 1949.

Range Research [1/]

Creation of the Office of Grazing Studies in Washington, D. C. in 1910 marked the beginning of formal recognition of range research as an important field of investigation. A Northern Rocky Mountain Regional Office of Grazing Studies was set up in 1913 to develop grazing practices applicable to national forest grazing in Montana and northern Idaho. Pressing administrative problems regarding both cattle and sheep grazing on national forest ranges were investigated and studies of poisonous plant eradication and range plant values, growth requirements, and distribution were begun. Because of financial crises, World War I, and personnel shortages, these studies were carried on somewhat intermittently until 1931 when the Division of Range Research was formally created. Even today some of the active work and line projects in range research bear a strong resemblance, at least in title, to these early undertakings.

Grazing Capacity

In 1915 determination of the proper range allowance per cow and sheep month and of the grazing capacity of the little known forest ranges were the most important range problems in the region. The answers to these questions were even more urgent because range inventory surveys were going forward currently and their usefulness depended upon establishment of proper range allowance and grazing capacity. Studies of cattle grazing in fenced range areas were conducted during four years, 1912 through 1915, on the Deerlodge Forest as a part of this project. Thereafter similar work was added on

---

1/ A range management research division was not established at the Northern Rocky Mountain Station until 1931. For the sake of completeness, some of the research accomplishments of the Grazing Office are included here.

Weighing sheep in a study of sheep grazing on Montana ranges.

---

other national forests with sheep as well as cattle. These studies provided the needed basis for stocking national forest ranges somewhere near their estimated grazing capacity. Combined with information from similar studies conducted in other regions, the results provided the basis for range stocking policies throughout the Forest Service and for U.S.D.A. Bulletin 790, "Range Management on the National Forests," 1919.

Soon after the establishment of the Division of Range Research, grazing capacity and utilization studies were begun on northern Great Plains ranges at the U. S. Range Livestock Experiment Station near Miles City in cooperation with the Bureau of Animal Industry and Montana Agricultural Experiment Station. These studies, designed primarily to aid in the better management of plains ranges, but also as a check on prevailing grazing and stocking practices, have established the average grazing capacity of northern Great Plains ranges and developed and tested guides to proper stocking of these ranges grazed by either cattle or sheep. Numerous publications summarize the high lights of 20 years of studies at Miles City.

The cattle grazing studies at Miles City have also shown the effects of range stocking on weights and gains of calves, reported in Montana Agricultural Experiment Station Bulletin 463, "Weight

and Gain of Range Calves as Affected by Rate of Stocking," 1949. Similarly, they have indicated the advantages of early marketing of surplus cattle (especially dry cows), of dividing the range for seasonal use, of a carefully regulated breeding season, and other phases of good range and cattle management.

A better understanding of range management and of the need for wise use of plains range lands has come from the study of responses or reactions of range vegetation and soils to grazing at Miles City. These data, as well as the effects of grazing on soil surface litter and moisture relationships, are contained in a manuscript now being processed for publication in the U.S.D.A. series.

Handling Sheep and Cattle on Forest Range

Early studies in handling sheep on forest range, conducted on the old Madison and Beartooth Forests, led to the development of the one-night bedding and blanket herding systems which are still in use today on national forests and some private ranges. Results of these studies, made largely between 1912 and 1915, were published in "Range Management on the National Forests."

Studies of the use of salt on the range to obtain better distribution of cattle were conducted on the Custer National Forest, and results, published in U.S.D.A. Circular 379, "The Use of Salt in Range Management," 1926, indicated that the use of salt on the range relieved livestock concentrations around watering places, promoted more uniform forage utilization, and enhanced the welfare of the grazing animals. Since 1931, these findings have been verified at Miles City, but a good deal of information has been obtained which is contrary to some earlier results.

Sheep habit studies at Miles City revealed a close correlation between the elements of weather and sheep movements. Consideration of wind movements, precipitation, and temperatures in planning grazing routes and overnight camps proved beneficial to the range and to the sheep.

Distribution and Forage Value of Range Plants

Determination of the distribution of range plants and their forage value was the first range problem to receive detailed study by both Bureau of Plant Industry scientists and Forest Service personnel. As a result there has been built up in the Washington Office the largest herbarium of range plants ever collected. In addition, many smaller collections such as those in the Divisions of Range Management and Range Research in the Northern Region have been developed. The project, although seldom reported or considered as a full fledged research undertaking, is still pursued largely by range research personnel. This continuing effort fills in gaps in the knowledge of plant ranges and occasionally reveals a species previously unknown in a locality.

Eradication of Poisonous Plants

Lack of well supervised range use resulted in animal losses from poisonous plants and focused attention on this problem in the early years. Knowledge concerning seasons of use and range grazing capacities helped materially to reduce losses from plant poisoning but did nothing to increase the availability or usability of infested areas. About 1926 chemical control was tried but tests were only moderately successful and the investigations were terminated after a year or two.

In 1948, after almost 20 years, interest in poisonous and noxious range plants was revived. New studies in goatweed control were started in northeastern Washington and these were followed by studies of 2,4-D and 2,4,5-T sprays on larkspur and Wyethia, on and near the Vigilante Experimental Range. Control of goatweed by biological means is one of the more intriguing current possibilities. A few colonies of goatweed beetles, Chrysolina gemellata, have been established in the western portion of the region. Also application of 4 pounds of borascu per square rod followed by reseeding of adapted forage species, though costly, promise to give satisfactory control of goatweed. The picture is even brighter for control of Wyethia amplexicaulis. Concentrations of 2,4-D from 6,000 to 10,000 parts per million of water or diesel oil, applied as light sprays, have given complete control in one season. This is considered a highly significant finding in the use of plant herbicide sprays on Wyethia.

Similar concentrations of 2,4-D did not kill or permanently injure tall larkspur.

Artificial Revegetation

Studies of artificial revegetation, or range reseeding, were started in 1919 and are now a regular part of the range research program. In the early 1930's a series of cooperative ranch scale plantings of crested wheatgrass led to practical acceptance of this plant as a supplement to native vegetation. Rehabilitation of low-value cheatgrass ranges by preparatory cropping and reseeding has become practicable since

Steers make good gains on abandoned cultivated land which has been reseeded to crested wheatgrass.

studies have shown the necessary steps for conversion to useful ranges.

Progress has been made recently in testing the adaptability of various range plants for reseeding use. Two new nurseries were established in the Inland Empire Research Center area during 1950. Pilot plants for additional future grazing and forage value tests are being established.

Forest Economics Research

The Forest Survey

Forty years ago two of the big questions in this region were: How much timber does the region contain? How long will it last if the current rate of cutting keeps up? Then the region was cutting about 1.3 billion feet of lumber; there were 140 sawmills and some new mills were being built. Fire, insects, and disease were depleting the timber supply. As previously pointed out, some of the best white pine timber in the region went up in smoke in the 1910 fires. Forest management was being talked about, but actually it amounted to little more than extensive fire protection. All these factors gave rise to concern over the future of the region's timber supply.

Estimating the extent of the timber resource was a favorite practice in years past and sometimes there was wide disagreement over the guesses. Many regionwide timber estimates have been made for various purposes. These included the Capper report of 1920, the Copeland report of 1931, the Joint Congressional Committee report of 1938, and finally the Forest Service Reappraisal Project of 1945. In 1931, recognizing that timber resource data were essential for developing a long time forest resource management program and acting under the McSweeney-McNary Forest Research Act of 1928, the station added the forest survey project to its program. This project had as its objective a systematic and accurate survey of the timber resource on all forest lands, both public and private. Work progressed through North Idaho, Northeast Washington, and Montana. Interrupted by World War II, the survey was finally completed for the entire region in 1950. It was then, for the first time, that the station had available reliable data on the timber resource of the northern Rockies and knew pretty well what was happening to this resource.

Briefly the forest survey showed that in the northern Rockies there were:

State unit	Area of forest land			Volume of sawtimber on commercial forest land
	Total	Commercial	Noncommercial	
	----- Million acres ------			- Billion bd. ft. -
Northeast Washington	3.9	3.8	0.1	14.9
North Idaho	10.3	6.9	3.4	50.4
Western Montana	13.0	8.9	4.1	39.7
Eastern Montana	9.3	6.8	2.5	16.3
Total	36.5	26.4	10.1	121.3

Equally important is what is happening to the timber resource. In the past 40 years large sawmills have come and gone. There are many more small sawmills now. New timber-using industries, such as pole plants, pulpmills, and a veneer mill, have come in. Fires have been reduced, and forestry has made many advances. But even so, the forest survey project has shown that some areas are being depleted. What is happening now to the sawtimber supply is shown by the latest survey data:

State unit	Gross growth	Mortality	Net growth	Cutting drain	Balance + or - 1/
	---- Million board feet of sawtimber ----				
Northeast Washington	313	121	192	200	- 8
North Idaho	1008	245	763	826	- 63
Western Montana	522	176	346	444	- 98
Eastern Montana	327	67	260	47	+213
Total	2170	609	1561	1517	+ 44

1/ Minus (-) indicates excess of drain over growth, and plus (+) indicates excess of growth over drain.

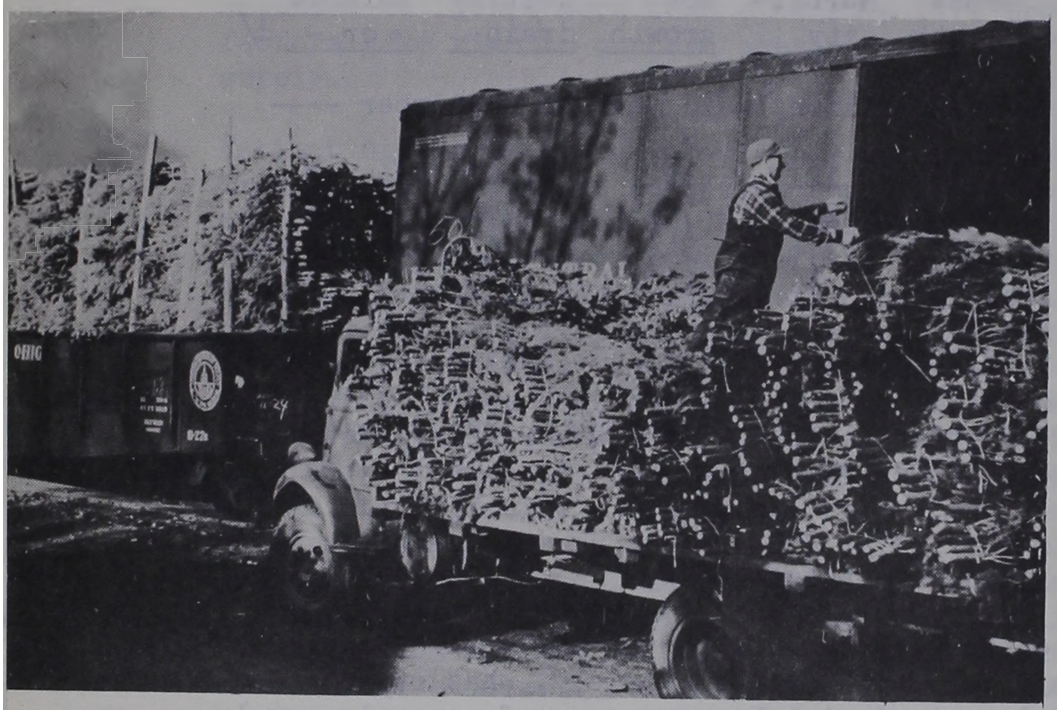
Forest Economics

Blister rust came into the northern Rockies in the early twenties and with it came a major economic problem, namely, what expenditure is justified from a value standpoint to assure us of an ample supply of white pine? Emphasis for many years was on blotting out blister rust, but as time passed it became more and more evident that the rust was here to stay and in the future we would have to concentrate our protection efforts on those stands that would give the highest volume and value yields for a given expenditure. The answer to such a perplexing question obviously would not be simple and would be most difficult to obtain.

As soon as the new Economics Division was set up in 1946 it teamed

up with the regional office in launching an economic analysis of blister rust work. In 1948, after 2 years of probing for facts and analyzing cost-value relationships, the regional office and the station published a joint report entitled, "Development of a Blister Rust Control Policy for the National Forests in the Inland Empire." This report pointed to the need for more intensive forest management if blister rust expenditures are to pay off, for ownership consolidation to assure continuity of management, for growing enough white pine to meet regional and national needs, and for an annual expenditure of some four million dollars for 5 years for blister rust control and white pine management.

To keep industrial development commensurate with the supply of timber products has always been a perplexing problem and the station has from time to time tried to resolve various phases of this problem. Back in 1915 market studies were initiated. In Butte, for example, a study was made of mine timber outlets. Another study of a similar nature was made in Coeur d'Alene in 1921. Thought was given to pulpmill possibilities and other wood-using industries that might bring about more complete and diversified utilization. It was in this connection that over the years complete data were assembled annually on lumber production, on prices of stumpage, lumber, and other forest products. Such material answered innumerable questions about the forest industries of the region, about the profitableness of the lumber industry, and provided much of the data necessary for subsequent economic studies.



Research has provided information on improved marketing practices for Christmas trees in the northern Rockies.

One of the industry studies drawing on early records was the analysis of marketing problems of the Montana Christmas tree industry. As a result of further study in 1948, a program was suggested for improving marketing, including adoption of tree grades, a grading rule, develop-

ment of consumer preference, and organization of grower associations.

Forest Products Utilization

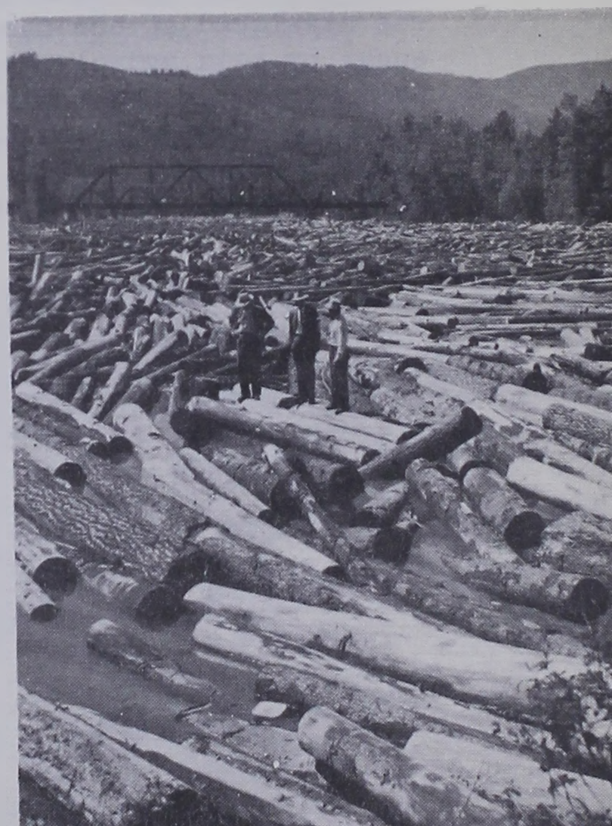
Timber Harvesting and Conversion

In the early years of the development of the forest products industries of the northern Rocky Mountain region, problems of timber harvesting and conversion were important. Lumbermen and foresters knew little about the quality of the trees and logs they harvested. At first simple mill scale studies were made to answer current needs and, following the first World War, regionwide logging and milling studies covering the ponderosa pine, western white pine, and larch--Douglas-fir timber types were made.

In the next 20 years there evolved from these studies many useful grading systems for ponderosa and western white pine trees and logs, for western larch peeler or veneer logs, and for western white pine flitches for knotty pine veneer production. The information on quality lumber production by tree classes formed the basis for selective cutting that is now practiced and advocated on tree farms and national forests of the northern Rocky Mountain region.

As high grade timber became less abundant and more inaccessible, the need for improved operating practices was recognized. Logging output and sawmill efficiency studies were started. In 1927 it was found that "turning down" white pine logs on the headsaw about doubled lumber overrun and increased the quality, hence the selling value, of the lumber from 15 to 30 percent. During the 1930's production cost and value yield data became increasingly useful because of the depressed lumber market. The need for up-to-date information carried over into World War II years and is even more pressing in the present period of high operating costs and inflated prices. In recent years, it has been possible for workers in the Division of Economics Research to team up with the new Forest Utilization Service in the solution of many utilization problems involving economics.

By the end of the second World War, truck transport of forest products had



Priest River log drive, recently abandoned in favor of truck logging because of log damage and long term log inventory investments.

displaced old Dobbin chutes and shorthaul railroads. One large company became doubtful of the economic desirability of driving costly white pine logs down Priest River, a practice that had prevailed for years. The Forest Utilization Service and the Division of Economics completed a study in 1948 that showed a river drive damage of $12 per M feet of logs. Elimination of this loss by conversion to truck hauling was feasible. As timber quality and markets change, new problems in harvesting and conversion will continue to arise.

Waste Utilization

Forty years ago logging and lumbering practices were highly wasteful but considerable progress has been made in eliminating waste in the woods and in the mill. Early surveys showed where the easiest and quickest savings in waste material could be made. Understanding of the waste occurring in high stump and large top-log diameters led to a gradual improvement of practices. Today high stumps are the exception and much of the log volume classed as cull 40 years ago is now utilized in the sawmill.

Waste involved in production of the region's 2½ million railroad ties was a serious problem. Surveys made in the late 1920's and early 1930's showed a loss of 1400 board feet of lumber in excessively thick slabs for every 100 ties produced. Today many mills salvage as much as 1100 or 1200 board feet of this former waste. This same survey called attention to the fact that more than half of the ties cut from trees 14 inches in diameter and smaller were low grade. Today many tie operators leave the small trees.

One of the best uses of wood waste is through its chemical conversion to other products. The Forest Products Laboratory works in this research field but the station has contributed to important phases of chemical studies that may lead to the use of a logging waste of 20 tons per acre and hundreds of tons of mill waste. One chemical process developed at the Laboratory was conversion of wood cellulose to sugar by acid hydrolysis. Samples of northern Rocky Mountain woods were tested at the Madison Laboratory during World War I. Yields of sugar amounted only to about 500 pounds per ton of wood processed. By the end of World War II, as a result of improved methods, recovery of sugar had been stepped up to 1000 pounds per ton of wood. Commercial

In the 1920's and early 1930's tie mills wasted 1400 board feet of lumber in excessively thick slabs for each 100 ties produced. Research and improved markets have made elimination of much of this waste possible today.

adaptation of the process seemed feasible. Cooperative studies arranged by the station with Montana State College (along with tests by other research institutions) have recently established the suitability of wood molasses for livestock feed. Successful use of wood molasses in pelleted livestock feed was also proved. In May 1948 the first pelleted livestock feed ever made in the United States using wood molasses as a binder and carbohydrate component was produced at a Missoula, Montana, feed mill.

Years ago it was determined that the sawdust pile, produced yearly by sawmills of the northern Rocky Mountain area, amounted to almost one-half million tons. Some of it was burned, some littered the landscape in a thousand different places. Gradually, through experimentation and demonstration, a concept for its use as a soil amendment has been built up. A recent station publication shows how aged sawdust has increased the yields on sugar beet lands. If properly used it is a good soil builder wherever a humus deficiency exists. Some ranchers now use new sawdust in the feedlot where it is impregnated with animal wastes prior to use on the fields.

Use of Secondary Species

Forty years ago the secondary or "mixed" species found little use. White pine and ponderosa pine sawlogs and cedar poles formed a stable base for the region's forest products economy, but many an operator went broke because he tried to harvest and market too much timber of other species. Western larch, lodgepole pine, and Douglas-fir were commonly used for railroad ties, although little was known regarding their service life. Early work by the Forest Service was directed at finding the suitability of all species for railroad ties. In 1910, before the establishment of the station, the Northern Pacific Railroad in cooperation with the Forest Service, installed test tracks with ties of all species common to the northern Rocky Mountain area. Creosote and zinc chloride were the principal preservatives tested at first but later arsenic trioxide and pentachlorophenol treatments were used. Observations of these test installations throughout the years by the station have indicated that practically all northern Rocky Mountain species give satisfactory service as railroad ties when properly treated with creosote. Today, ties of most of the mixed timber species are accepted and used by the Northern Pacific Railway as a result of these tests.

As previously mentioned, the use of lodgepole pine has fluctuated widely but, because of research, it is finding greater utility today. Before there was a Forest Service, the mines of Butte were using thousands of tons of lodgepole pine charcoal and huge quantities of round lodgepole pine timbers for stull, lagging, and framing timbers. About the time the station was established, mining engineers switched from round timbers to more sawn material and the slump in lodgepole pine use had begun. Between 1910 and 1920 numerous experimental installations were made to determine the service life of lodgepole pine butt-treated poles and posts. Today we know poles and posts of this

species, given a good creosote butt treatment, will last 25 to 35 years in the semiarid valleys of the west. Twenty years ago tests to determine the mechanical properties of lodgepole pine for telephone and electric light poles were started. Working stresses and specifications were worked out for lodgepole pine during the past 10 years. Today it is listed by the American Standards Association as one of the important pole species.

One of the more important functions of the station's Forest Utilization Service is to direct important forest products problems to the Forest Products Laboratory. Over the years, many new uses for the region's little-used species have been made possible from this joint research effort. The establishment of the suitability of lodgepole pine for groundwood, sulphite, and sulphate pulp is a good illustration. Wisconsin paper mills now ship more than 50,000 cords annually from Montana, 1600 miles back to their mills. The outlook for use of lodgepole pine as a pulping species is exceptionally bright.

Western larch is another of the secondary species that has been unpopular for many years. Consumers always associated lumber from western larch with its eastern relative, tamarack. Research over the years has established the true properties and characteristics of this wood. As lumber it now ranks along with coast Douglas-fir. Mechanical strength tests made at the Laboratory have given it a high strength rating as a pole. Today it stands at the head of the list of all species in the American Standards Association specifications with an assigned working stress of 8400 pounds per square inch. Western larch is now established as one of the nation's transmission pole woods.

Research has also proven larch suitable for veneer and plywood production. Study by the station has indicated that virgin larch stands yield 10 to 20 percent of peeler logs suitable for rotary cut veneer. Sliced veneer cut from edge grain flitches produces most intriguing patterns for door facing and wall panels. The first sliced veneer plant in the northern Rocky Mountain area producing western larch veneer is now under consideration.

Forest Fire Research

Fire research is a field in which results are likely to be spectacular. Even with some allowance for this fact, the station's contributions from fire research are outstanding. Although a modest start was made in 1916 (a study of climate and forest fire occurrence), a fire research program is conspicuous by its absence during the first decade. The annual report at the close of 1919 contains these words, however: "The unusual fire conditions of the past year further called for recommendations that have for their object information of conditions and means for better fire protection. Fire protection has become of such importance as to subordinate other considerations." But it was not until 1922 that a full-time fire research worker was assigned to the station.

Fire Weather and Fire Danger Measurement

The silvical studies of environment, begun in 1911, contributed to an early understanding of forest-weather relationship. An exhaustive study of climate and forest fires was published in 1922. Later, a better understanding of the specific relation of various weather elements to fuel moisture was developed. A real contribution in the forest-weather field has been the unbroken operation of the Priest River weather station, summer and winter, since 1912. This probably represents the longest continuous record collected at a truly forest-weather station in the United States.

Studies of fuel moisture and its response to weather changes soon showed that a direct measure of moisture in duff or slash was far more dependable than its indirect determination from measurements of temperature, relative humidity, evaporation, or precipitation. Pioneering work with duff hygrometers and fuel moisture indicator sticks not only produced a practical system of fuel moisture measurement in the northern Rockies but was an incentive for other workers to develop similar devices now so commonly used throughout the entire United States.

Studies of fuel moisture in relation to weather preceded the development of the fire danger rating system.

Measurement of fuel moisture wasn't enough, and in the late 1920's it was apparent that the practical fire man needed a device that would express "fire danger." In 1931, the first fire danger meter was devised which would integrate measurements of fuel moisture, wind, rain, season of year, occurrence of lightning, and visibility distance into one numerical danger rating. The use of fire danger meters has swept the country since that early date and the one in use in the northern Rocky Mountain region has continually been refined and improved as additional information has become available. Today many fire prevention, preparedness, and suppression activities are directly geared to fire danger which is rated daily during fire seasons at some 200 forest stations. The savings resulting from having protection facilities available when they are needed undoubtedly total more than the entire amount spent for fire research. Two major publications summarize the fire weather and fire danger work: "Measuring Forest Fire Danger in Northern Idaho," U.S.D.A. Miscellaneous Publication 29, 1928, and "Measuring Fire Weather and Forest Inflammability," U.S.D.A. Circular 398, 1936.

Fire weather studies showed fire protection men when to measure danger but additional work was necessary to indicate where danger stations should be located. Such studies proved that zones of high danger exist at different altitudes and on different aspects as fire seasons progress. Not only can danger stations be placed to measure conditions in the bad zones, but danger ratings can be modified and interpreted on the basis of the findings so as to be most useful. This work was summarized in 1941 in U.S.D.A. Circular 591, entitled "Influence of Altitude and Aspect on Daily Variations in Factors of Forest Fire Danger."

Fire Control Planning

At the head of the list of accomplishments in the fire-control planning field is the adaptation of many engineering concepts to fire planning. In 1930, 12,000 fire reports were analyzed and used as a basis for an extensive planning job. During the past 3 years a reanalysis of 36,000 fire reports, going back to 1910, was made and provides a new basis for refinements in fire-control planning. It is significant that these planning jobs were made possible by the excellent fire records available to research. The foresight of research and administrative men alike in insisting that fire reports be prepared accurately and checked each year has proved invaluable.

Outstanding among the many innovations in fire-control planning was the development of fuel type classification. By means of this system fuels are rated by a dual standard of rate of spread and resistance to control. Fuel maps showing fuel types were the keystone for all presuppression planning. During the early 1930's a tremendous planning job was under the direction of station personnel. It included lookout placement studies, communication plans, transportation plans, and many necessary companion studies such as the development of a visibility meter.

The analysis of 40 years' fire reports, previously mentioned, has been completed during the past year. It brings the statistical base for fire planning up to date and is unquestionably one of the most exhaustive studies ever made in the fire field. Of special significance is the attention given to several aspects of aerial fire control such as aerial detection and smoke jumper fire suppression.

Fire Behavior

Fire research workers from the beginning have felt the need for a better knowledge of fire behavior. The eventual conquering of the "big fire problem," which still gives us the greatest fraction of our losses, will rest on an adequate knowledge of fire behavior in relation to fuels, topography, and weather. The use of fire in silviculture or for fuel reduction requires an intimate knowledge of fire behavior. Observations of going fires and analyses of fire reports have been made by research men to gain a better understanding of fire behavior. Progress has been made, but much remains to be learned. During the past year a fire behavior meter was developed and tested as three field stations. This device, based on all previous fire report analyses and studies of actual fires, will show dispatchers what to expect from fires burning under various combinations of fuel, topography, weather, and elapsed time.

Prevention

All through the years station men have worked on various aspects of the logging slash disposal problem. In the early years work centered around broadcast burning, then a common practice. Later the effectiveness of piling and burning was established. Unsolved today, however, are many problems such as 1) piling and burning versus heavier protection of areas with slash unburned, or 2) effect of slash burning on soil and water values.

At intervals over the years, proposals to prevent lightning -- the number one fire starter -- have been made. In the early 1920's and again in 1934 it was suggested that an area be equipped with lightning rods and the fire record compared with that of an area not so equipped. Such tests of "lightning proofing" were never made. In 1948, however, through the cooperation of Dr. Vincent Schaefer of General Electric Research Laboratories, a study was made of the possibility of seeding certain types of clouds to dissipate their lightning-forming potential before they began discharging into forested areas. Significant pioneering work was done but due to an unusual absence of thunder clouds in 1949 no actual seeding tests were made. In 1950 an analysis of lightning storm types added to our knowledge of opportunities that lie ahead in this field, one that offers considerable future promise.

Aerial Bombing

In 1919 it was recommended that "The Madison Laboratory determine

Aerial bombing is effective in checking fire spread under some conditions but it requires costly equipment and highly trained personnel, available only to the U. S. Air Force at the present time.

---

whether gas bombs (dropped from aeroplanes or dirigibles) would have any promise of success in fire protection." Since that date, the use of aircraft in fire suppression has intrigued investigators. Experimenters in the 1920's and 1930's made numerous dropping tests to establish the feasibility of water or chemical use. Others tested spray patterns with water and foam materials by dropping "bombs" from towers. All of these early studies were limited and handicapped by lack of necessary equipment. In 1947 a real chance to test aerial bombing of fires was made possible by the cooperation of the U. S. Air Force. From exhaustive tests on actual fires, it was concluded that aerial delivery of water-filled bombs was an effective means of retarding fire spread under some conditions but that it held little promise to fire suppression agencies without Air Force cooperation. Effective bombing requires military type aircraft, precision bombing equipment, and highly trained personnel, all of which are now outside the financial reach of fire agencies. However, it is possible that future developments in equipment and fire retarding chemicals

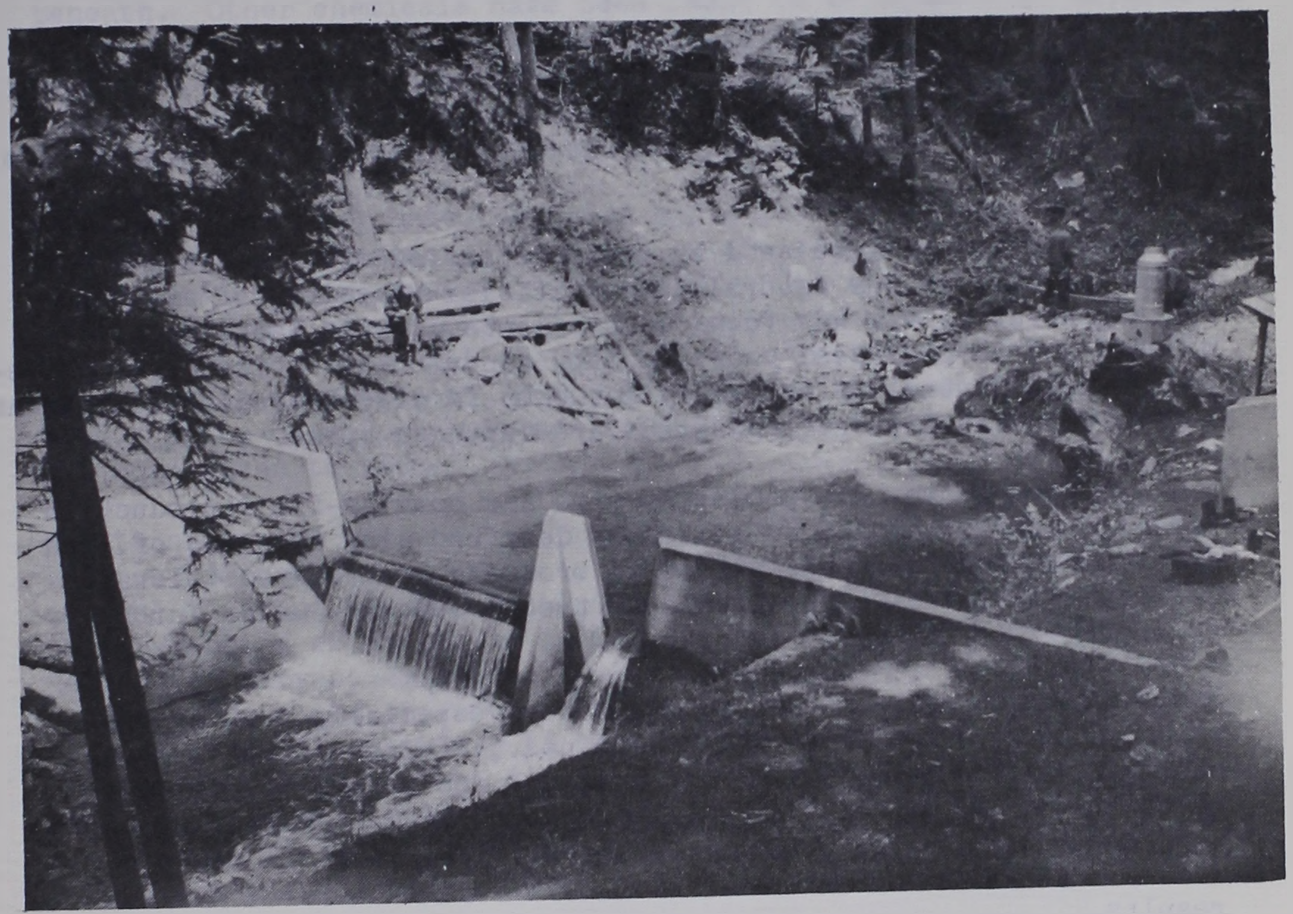
may make aerial bombing a highly profitable venture.

Water Resource Management Research and Flood Control Surveys

Investigations in the field of water resource management have been neglected over the years, far more than any other branch of forest research. For at least 25 years, however, research workers have continually stressed the need for organized study of the influence of the forest and range on water and soils. Some basic information on the relation of forests to local weather conditions has been accumulated as part of silvical and fire studies.

Recognition of the flood control problems requiring study has been emphasized in the past. In 1937 and 1938 a preliminary flood control examination was made in the Spokane River watershed. It was 10 years later (1948) that a Flood Control Surveys Division was established for work in the Missouri and Columbia Basins.

Detailed study of streamflow began in 1938 when a stream gage was placed in operation on Benton Creek, one of the two water courses



The stream gaging station on Benton Creek, the only one of its kind in the region.

at the Priest River Experimental Forest. This was the first small-gaged watershed in the northern Rockies and at present is the only one wherein watershed cover conditions as related to precipitation and runoff are being studied, such studies having been started in late 1948. Shortly after the establishment of the Division of Flood Control Surveys additional records and data were taken at Priest River as part of flood control advanced studies. These include snow accumulation and melt; and wind, temperature, and humidity information as related to cover, elevation, and aspect, and reflected in streamflow.

As a part of its survey work, the Division of Flood Control Surveys is bringing together data from many sources, data which will be of value to any future research in the water management field. Some of these data and sources include: snow survey information from the Cooperative Snow Survey; physics and mechanics of snow melt from the Upper Columbia Snow Laboratory; weather records of the Weather Bureau; runoff and streamflow figures from the U. S. Geological Survey; much original information collected as part of regular survey activities.

Wildlife Research 2/

Studies of wildlife in relation to forests are handled by the Fish and Wildlife Service in cooperation with the station. Work started by a biologist in 1941 was interrupted by World War II but was resumed in 1946. The study program has been limited to forest-wildlife relations.

The destruction of tree seed by seed-eating rodents has always been a problem both in the natural and artificial reseeding of areas being regenerated. It was found that rodents consume large quantities of seed and in poor seed years usually consume the entire crop. Therefore rodent control is necessary not only in direct seeding operations but in some cases where seed trees are depended upon.

Studies have shown that ponderosa pine and Douglas-fir reproduction can be severely damaged or killed by deer browsing in areas of high deer concentrations. The extent of browsing that can be tolerated and the relation of shrub browse to tree browse are under further study.

Small mammals create forest problems too, especially such damaging animals as snowshoe hares and porcupines. Studies of the control of hares, which damage pine reproduction, are under way. It has been found that porcupines, which do extensive damage to pine sapling growth, build up in cycles by localities. Control measures should therefore be correlated with local cyclical peaks for best results.

2/ Prepared from material submitted by Lowell Adams, Biologist, Fish and Wildlife Service, Missoula, Montana.

Forest Insect Research [3/]

Bark Beetle Control

Bark beetle control in the United States was first attempted during an epidemic in the Black Hills Forest of South Dakota in 1906. The early control projects of the northern Rocky Mountain area were on a similar emergency trial-and-error basis. To correct this condition the Bureau of Entomology was directed to do the research necessary to place forest insect control on a sound technical foundation. In the territory served by the Coeur d'Alene Laboratory, bark beetle control has moved forward in intensity and thoroughness, keeping pace with the practice of forestry.

Development of effective and economical measures of treating trees infested with bark beetles has been a long, laborious task. Many methods have been tested including felling and peeling, girdling, use of fire, injection of chemicals, and variations or combinations of these treatments. These experiments have led to the development of the "penetrating spray" method of treatment in which orthodichlorobenzine in a fuel oil carrier is the lethal agent. This spray penetrates the bark of infested trees and kills bark beetle broods beneath. Other chemicals have been found to be equally as effective. Although successfully used against most Dendroctonus beetles, the present formulae are not effective against a few species. Penetrating spray has become a standard method of treatment in other areas as well as in the northern Rocky Mountain region.

Methods of treating infested trees had a direct bearing upon the cost of control projects. However, other technical information was recognized as being essential to an effective and economic administration of such operations. Seasonal histories, attack and flight habits, and environmental factors which influence changes in beetle populations, were "musts" in the development and application of control. These questions have not been answered fully, but much work has been given to them.

In attacking the bark beetle problem, the Coeur d'Alene Laboratory has not limited its thoughts to direct control of outbreaks. Direct control is but a temporary solution for an immediate problem, but the prevention of epidemics is the ultimate hoped for solution. Methods of harvesting mature timber stands within this region now revolve around the prevention of bark beetle damage, and the creation of residual stockings of beetle resistant trees. Much fundamental work remains to be done in this region before these developments can become a full reality.

3/ Prepared from material submitted by James C. Evenden, Entomologist, Bureau of Entomology & Plant Quarantine, Coeur d'Alene, Idaho.

Other Insect Problems

Forest defoliating insects have occurred in such epidemic populations that serious regional problems resulted. The insects responsible, as well as the effects of defoliation, have been a subject of much study. For many years there were no feasible control procedures. Dusting or spraying from the air was considered as the only possible solution and that seemed far distant. DDT, and other new insecticides that were found to be effective in light dosages, made this far distant control potential a reality. The North Idaho Tussock Moth Control Project of 1947 opened the way for other large scale aerial forest spraying projects.

From time to time many other insect problems have appeared on the work program of the Coeur d'Alene Laboratory. These have varied from insect damage to shade trees and shrubs to the damage of crude and finished forest products. Such problems have been accepted as so-called "quickies," and solved to the best of the laboratory's ability.

It is difficult to portray progress without recounting many non-interesting details. Perhaps the degree of progress made could be measured in a simple statement. For example, 40 years ago forest entomology was new to our nation, but today it is a recognized profession taught in many universities. Forty years ago entomology's place in forestry was obscure, but today it holds a prominent position in all forest protection programs. It is believed that this rise from a humble birth to its present position speaks well for the progress of forest entomology. In this progress the Coeur d'Alene Laboratory has contributed its share.

Forest Pathology Research 4/

With the early emphasis on harvest cutting in mature timber, the pathologists found it productive to work on many problems related to timber harvesting during the period 1911 to 1921. Pathological marking rules were developed for the principal tree species of the region. Information on pathological rotations was obtained. Regionwide inventories of native diseases and basic studies of the disease aspect of forest ecology laid the groundwork for later progress in disease control.

By 1921 forest pathologists realized that the white pine blister rust was bound to get into the Idaho and adjacent white pine stands. Although no resident pathologist was headquartered at

---

4/ Prepared from material submitted by C. D. Leaphart, Pathologist, Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering, Missoula, Montana.

the station, the Division of Forest Pathology carried on an active blister rust research program from that date. A lot was learned about the disease, the rate at which it spread, and the damage it caused in the climate and topography of Northern Idaho. Control of blister rust has continued to be the responsibility of the Blister Rust Control Office over the years but the Division of Forest Pathology still is doing all federal research on the disease.

In 1938 a concerted effort was directed toward a study of dying young white pine. At the time mortality was thought to be caused by root diseases. As a result of cooperative work on the project by the University of Idaho, the Bureau of Entomology and Plant Quarantine, and the station, it was decided that an entirely new disease was causing the mortality. This disease, which in recent years has been called pole blight, has received most of the attention of pathologists in the region during the past decade. Successive efforts in 1942 and 1947 produced no solution to its cause. Five different agencies, including a Canadian forest pathology unit, are now working in close cooperation on this project.

A LOOK AHEAD

When one looks ahead from the perspective of past changes and trends, he cannot help but be highly optimistic over the future of forest resource management in the northern Rocky Mountain region. True, his optimism must be tempered by the present world situation and the demands upon our country and its resources which are mounting every day. There can be no doubt that "the good old days" -- days noted by a lack of concern for the future -- are gone forever. But the northern Rocky Mountain region is ready to contribute in a much different way to the economic and social welfare of the Nation.

Before 1900, this region was still a wilderness to be explored and exploited, rich in timber, minerals, forage, and furs. Then, as the Forest Service was created, there developed a custodial philosophy -- one of preserving natural resources. In the last two or three decades there has been a steady shift from the idea of custodianship to one of management and use both by public land managers and by some private land owners. Now, in 1950, we stand on the threshold of an era of development of timber, forage, water, recreational, and wildlife resources never thought possible by many whose vision was obscured by the steep mountains, the dense forests, and the endless prairies.

It has often been said that there is a rapidly increasing pressure on forest land in the northern Rocky Mountain region. Conflicts in use have arisen. The timber manager wants to thicken his stands but that shades out understory vegetation and reduces available forage. The water resource manager wants to create openings and reduce stand density to increase snow accumulation and water yield, but such a practice may reduce timber revenues. Conflicts between

sportsmen and stockmen arise over the use of forage by big game and livestock. Watershed values are reduced by concentrations of game. The fire protectionist wants to burn out hazardous fuel accumulations but the soil and water problems may be intensified by the practice. And so the conflict goes.

Adequate integration of forest land management is a difficult but not impossible task. Rationalization of conflicts can be made readily if a sufficient understanding of relationships is available. The task of research workers in supplying the necessary information is a challenging one. This job stands out as one toward which our efforts in the future must be constantly pointed.

A look ahead reveals many changes that are almost sure to occur -- changes that will influence what we do in the research field. In the first place, our back country is being opened up. Many inaccessible areas will soon have good roads into them. There will be an increasing demand for timber, forage, water, and fish and game as population pressures increase and agriculture and industry expand in the northern Rockies. Greater use of machinery and equipment, perhaps of new types, is almost certain in timber harvesting and in fire protection. Young, second-growth stands which came in after fires and early logging will be replacing in importance the original virgin forests of the region. Greater potential incomes from managed forest land will necessitate and justify more intensive protection from fire, insects, and disease.

With this forecast of things to come, it is not difficult to present the problems that research workers will be called upon to answer. Many of them have a familiar ring. In the years ahead we hope to point as directly as we can to the study of the problems outlined in the following pages.

Timber Production

A Basis for Intensive Management

While timber supplies were still plentiful, relatively simple forestry practices were sufficient, but with an increasing timber consumption and declining supplies of quality growth, management is certain to become more intensive. We shall demand that land be kept producing timber more nearly up to full capacity. With greater accessibility, improved logging methods, and closer utilization, there will be an opportunity to cut over forest stands oftener and on a more scientific basis. The "know-how" of intensive management will be in greater demand.

Intensive management, particularly where the same acres are under multiple-use pressure, will require a far better understanding of the basic relations of trees to their environment. What are the nutritional requirements of the trees with which we work? What are

the soil-site requirements of species that control extension of types or substitutions of species? What are the important limitations of various forest tree mixtures? How does intensively applied silviculture influence the important biological balances of the forest? Such questions as these will be near the head of the list, and research in forest soils, tree physiology, and forest ecology will continue to bear fruit.

Although the old-growth virgin forests will continue to supply much timber for many years, cutting in second-growth stands has begun and can be expected to increase at an accelerating rate. Second-growth stands differ from old-growth in age, vigor, species composition, growth, volume per acre, and kinds of products that can be extracted. New marking practices must be devised in order to obtain the highest yields. Development of schedules for commercial thinning in immature stands is especially important. Managers will need much new information on rates of growth in second-growth stands that have been thinned or given an improvement cut. The silvicultural and financial aspects of all the effective cultural practices such as weeding, release cutting, pruning, or sanitation cutting must be worked out.

Improvement of Timber Species

Although more timber will be produced as we master the art of intensive management, it is certain that great additional strides can be made through an improvement of the trees we grow. Forestry is the only large segment of the agricultural arts which has not yet made substantial advances in the application of genetics as a means of increasing production. Our forests represent a highly variable population of individual trees. Some grow rapidly, some slowly. Some are inherently of good form; others are limby and rough. Some few seem to resist insects and diseases; the majority do not. Some produce bumper seed crops regularly and thereby make natural regeneration easier; others are poor seed producers. These are only a few of the natural variations known to exist in all of our important species populations.

The development of superior trees will require selection of desirable parent stock, breeding and propagating, and finally progeny testing. Much needs to be done before we have an adequate basis for selecting trees that grow fast, prune readily, resist disease, or produce a dozen other desirable characteristics. The techniques for controlled breeding and propagation have been worked out for many species. Methods of inducing early flowering have cut the breeding rotation down to 10 years in most species. Improved methods of testing progeny must be developed, however, so that selections of superior trees may be made at an early age from large numbers of progeny.

Opportunities lie ahead for improving naturally reproducing timber stands through recognition of superior trees during the marking job. However, we need to develop reliable guides that can be used

Schedules and guides for thinning in immature stands will be needed in the future. Before and after a trial thinning in a young white pine stand.

---

by the timber marker so that he can do a better job of identifying trees which have superior characteristics.

Further work needs to be done in testing racial characteristics so that seed collecting will be on a sound basis. Planting programs will undoubtedly increase in the future as idle cut and burned acres are brought into production, upper fringes of watersheds are afforested, and as intensive management requires prompt artificial reforesting of cutovers where natural regeneration is slow or uncertain. Only a seed collection program based on an adequate knowledge of racial characteristics will result in general planting success.

Utilization

The Wood Waste Problem

The people of the northern Rocky Mountain region are typically American in their general lack of concern over materials they waste

in everyday life. One of our big problems here is to find ways to use the material now wasted and to do it at a profit. About 500,000 tons of sawdust are produced annually by small mills in the region and 600,000 cords of residual wood are left each year after logging. These materials are suitable for manufacture into many things such as fibre board, fuel briquettes, wood molasses, and other products. Additional research is needed to perfect the technical conversion processes as well as local study of ways to organize and adapt sawmills and manufacturing plants to the use of waste.

Huge stockpiles of dead wood now go unused in the region. Mortality from insects, disease, and fire currently is adding to the volume of the material. Five million cords of beetle-killed timber are available. There are probably numerous ways in which all dead material could be salvaged and used. Research must find out.

Use of Secondary Species

At present western white pine and ponderosa pine are the backbone of the lumber economy in the region. Both species are being seriously overcut for saw timber. But other less-used species are still in good supply and are growing faster than they are being used. In addition, some mature stands of these secondary species, such as lodgepole pine, are deteriorating rapidly. In order to stimulate the use of lodgepole pine, larch, Douglas-fir, white fir, and other species, and thereby relieve western white and ponderosa pine, we must learn more about their properties and uses. What are they good for? Paper pulp, veneer, lumber, transmission poles? Methods of seasoning and handling must be worked out. Adaptation of gang-type sawmills or other new sawmilling practices to local conditions will be needed if small

Development of pulpwood markets in the future will help solve forest management problems. Cutting and loading lodgepole pine pulpwood on the Gallatin National Forest.

logs are to be handled at a profit.

Not only will the use of secondary species relieve pressure on those of greater value but by their use and removal we will solve many silvicultural problems. The regeneration of ponderosa pine, for example, would be surer if seed producing Douglas-fir could be removed to a greater extent. The thinning of young white pine stands would be financially feasible if a better pulp market for small-sized material were available.

Industrial development per se is one thing; development commensurate with the ability of the forest to support an industry is something else. In the past, most attention has been given to the former. In the future, emphasis needs to be placed on locating and selecting new industries that can be supported by the timber economically available. This calls for study of the resource and the industry. Studies should be pointed toward development of outlets for secondary species and use of logging and milling waste as previously discussed. Furthermore, market needs should be recognized. The other components of industrial needs must be considered; for example, water requirements for pulpmills, labor needs, and competition of other forest industries for timber. Studies of this type could help bring permanence and stability to forest communities and broaden the economic base of the northern Rocky Mountain area.

Forage Production

Grazing Management

As previously pointed out satisfactory answers have not yet been obtained to certain phases of some range problems which were recognized

Determination of range conditions and trends still presents a problem that research must help solve.

early in the history of the station. In the field of grazing management we still lack sufficient research experience to specify accurately the best intensities of stocking and seasons of grazing for many mountain summer range types on the national forests. In many cases large areas of such range have been used by one class of livestock according to a given system or pattern for years, which at best was originally only a guess at proper management. Consequently, deterioration of the range, its grazing capacity, and watershed values has continued. Land administrators are reluctant to change present practices even though faults are clearly recognized and in many cases they will not change until research has definitely shown the merits of other management systems.

Range management knowledge is also deficient with regard to utilization standards and criteria for estimating range condition and trend in condition. Although studies of western-wide scope and with national direction have been conducted in these lines, local intensive effort is needed to get the job done.

Control of noxious range plants, another line of grazing management research, has long been given attention by private and public land administrators alike. In the northern Rocky Mountain region, the problem centers largely on goatweed, tall larkspur, Wyethia, sagebrush, halogeton, and many others. Noxious plants are now, or are likely to become, problems on the range. Although only a few plant species are sufficiently poisonous to cause heavy livestock losses, all are responsible for losses in range grazing capacity and reduced production of meat, hides, and fiber from the native ranges. Satisfactory methods of controlling these plants cannot be developed or effectively applied until the ecology of each species has been thoroughly worked out. Research can contribute much to noxious plant control.

Range Revegetation

More than 8 million acres of range land throughout the West have been successfully reseeded during the past 20 years, but this is only a small part of the area in need of revegetation. There are many problem areas in the northern Rocky Mountains where practical systems of range improvement can be practiced as soon as we learn what, when, and how to plant. Much needs to be learned about the grazing value of adapted species, their palatability, meat producing qualities, resistance to grazing, and other characters not yet studied.

Managing the Water Resource

In a region that embraces the headwaters of two of the Nation's mightiest rivers, the Columbia and Missouri, water resource management is sure to be of utmost importance in the future. At the present time the station has two major goals in the field of flood

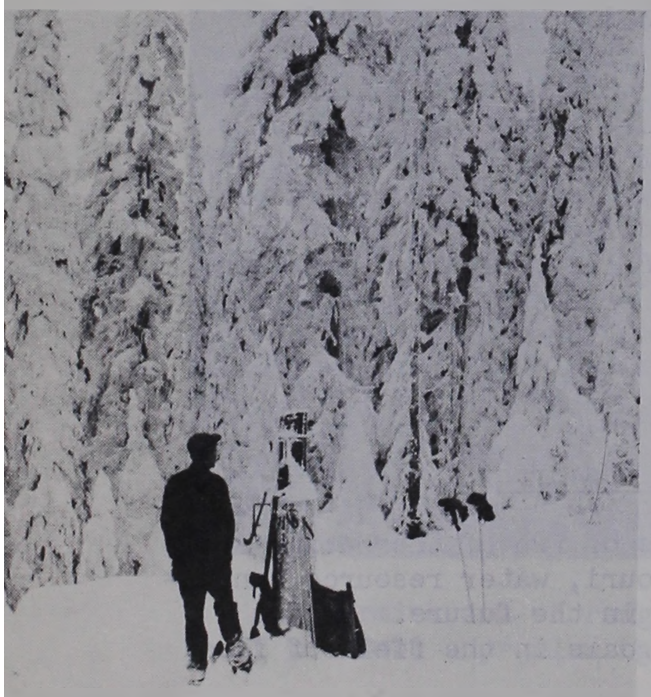
control and watershed research. An immediate objective is the completion of the Flood Control Survey for the Columbia Basin area and its incorporation into the U.S.D.A. Columbia Comprehensive Plan. This goal will be reached by June 1953. The Missouri Comprehensive Plan was completed in 1949.

The Missouri and Columbia Agricultural Plans provide for a program of long-range water resource management research, already authorized nationwide, but never extended to the northern Rocky Mountain region. To get an active program of research underway is the second major goal for the future. Without such a program, integrated land management can never be accomplished. Under such an organized research program, work within several broad categories would be undertaken.

Need for Basic Data and Relations

Before water resource management research can progress very far, it will be necessary to collect basic data and records on meteorological, climatic, and hydrologic factors. In this region of cold winters, heavy snows, and inaccessible terrain, there is an acute shortage of basic statistical information for all but the low-lying valley areas where it has been convenient to maintain weather and streamflow installations. One of the first jobs, therefore, will be to collect and study basic data for mountainous wildland areas in order to ascertain how these records vary from those taken in the valleys; how precipitation patterns change; how snowfall and melt rates fluctuate; character of flows from high-elevation tributaries; and many other important factors.

With minor exceptions, the wildland soils of the northern Rocky Mountains have not been mapped, classified, or described. Basic geological information is not available for much of the area. Any water resource management research in this area will have to include many investigations of forest soils -- their character, extent, location, moisture relationships, erosion susceptibility, productivity, limiting factors.



Basic information on snow accumulation and melt is only one of the many kinds needed before a sound watershed management program can be developed.

Forest and range surveys have built up an inventory of vegetal cover which forms a good base from which watershed cover studies could be initiated. In this area where such a high percentage of streamflow originates from snow melt on wildlands, very little is known about the water (snow) cycle and how it is influenced by various cover types and conditions. How much precipitation is intercepted by lodgepole pine, by larch, by mountain brush? Are there transpiration losses in the winter season? What are the frequency and character of soil freezing? How does water yield vary by cover types? What relationships exist between vegetation and soil characteristics? These are just a few of the many unanswered questions.

Management of the Watershed

In other sections of the country, it has been demonstrated that certain uses and management practices can enhance or destroy the water resource. In this section, it is known in a general way that large forest fires adversely affect water flows. On the other hand, controlled broadcast burning of slash in several types is the accepted fire protection and silvicultural practice. Is burning compatible with good watershed management? Must the great risk of runaway fires in undisposed slash be accepted? Overuse by game and domestic stock will lead to cover depletion and soil deterioration. Criteria -- based on soil, cover, and other factors -- need to be set up so that the watershed requirements of range areas may be easily recognized. Many questions arise as the result of timber harvesting. These are all complicated by various logging methods, road construction practices, slash disposal methods, type of logging equipment. Little is known as to how or how much the water resource is influenced by these practices. As use extends into new types, higher elevations, poorer sites, shallower soils, the watershed problem becomes increasingly important and complex.

As demands for water increase and the importance of water is stressed it becomes more and more important to know what values are at stake and what action programs are economically justified. In the past five years we have heard a lot about the value of water coming from the forests, but to translate the value into justification for more intensive land management, financial guides are essential. So far, little has been done to evaluate the water resource of wild land. What are the public values involved? What is the value of clear, palatable, municipal drinking water? What public loss is suffered through reservoir sedimentation? What has been lost when the top soil is eroded away? What is the future value of timber versus water? What modifications in timber yields are warranted by water values? These and other related economic questions will loom larger and larger in the future. It is important that guides be provided the forest manager.

As it becomes possible to evaluate watershed values, criteria should be set up as guides to watershed management. The application of these criteria or guidelines would permit the classification of

tributary watersheds as to management objectives, priority of uses, multipurpose adjustments, and over-all integrated use.

Animals and the Forest

While research in game management and animal pest control is not a responsibility of the station, we are responsible for learning how to produce timber, forage, and water in harmony with animal populations. Only through a better understanding of the complex relations of animals to their environment can we achieve a high degree of skill in managing both the forests and the animals in them. The cooperating biologists of the Fish and Wildlife Service view research in wildlife ecology as one of the most important future fields that needs intensification.

The interrelation of animals and the relations of animals to trees may be complex. For example, the extent of the destruction of ponderosa pine seed by mice is related to the kind and distribution of animals that prey on mice. These predators may be fur bearers which need management, or they may be pests such as coyotes which need control. Both management and control must be based on research findings. To control coyotes without determining their effect on mice is to risk benefiting mice at the expense of the forest. Concurrently, control of coyotes in overstocked deer range may result in destruction of pine reproduction by deer. Each species of animal is a link in the ecological meshwork to many other species and directly or indirectly to the economic welfare of man.

In the future, wildlife research workers will have to supply many answers to the problems of integrating game production with the production of timber, forage, and water. Similar problems of fish resource management should receive the attention of fishery research biologists.

Protecting the Forest

In spite of the advances in fire protection and the good records of the past 10 years of favorable fire weather, we have been losing a considerable volume of commercial timber and young growth by fire. Insects and disease take a heavy toll also. The kind of management we believe necessary in the future will require close control of these damaging agents.

Fire

Great strides have been made in fire protection and the record for public and private agencies is generally good -- on the average. But there are still some places where we are taking losses that cannot be tolerated. On the national forests our record has been good except in the occasional critical year. But less than one percent of

Large fires like this one still cause most of our losses and their prevention and control are major problems of the future.

---

the fires in the 15-year period 1931-1945 produced 94 percent of the acreage burned. The biggest and most damaging of these fires come in the few critical seasons. How can we reduce the number of these large fires and the losses they cause? That is the most important future problem confronting fire research workers.

The large-fire problem must be approached from three directions. First we must learn how to recognize combinations of weather, fuels, and topography that are conducive to large-fire occurrence. When are fuels reaching the dangerous stages of dryness and winds the critical velocities? We have not yet learned enough to enable us to evaluate these conditions infallably. In what fuels can we expect large-fire potentials under critical weather conditions? How does topography help set the stage for a blow-up under these same conditions?

Second, we must learn more about fire behavior in different fuels and on different slopes. What basic rules govern the action of a fire? What are we missing now when we misjudge fire behavior and continue to lose timber, forage, soil values, and even human life?

Third, how can we do a faster and surer job of fire suppression? On the large fires our output of held fire line amounts to only about 6 feet per man-hour. We are carrying more men to fires in trucks, delivering them by airplane, and using all the modern transportation innovations but are still depending mainly on the same hand-tool attacks we used 20 or 30 years ago. What can research do to help increase line building, crew organization, and output in the fire suppression job?

In the field of fire-control planning, much needs to be done. The fire job is constantly changing as roads make country more accessible, as new technological developments become available, and as we intensify or change our management of forest lands. One big task of the future will be the integration of fire protection more

completely with land management objectives. Where and under what conditions should logging slash be left unburned? What intensity of protection will be needed on watershed lands? How can fire be used as a tool in timber, range, and wildlife management? These are only a few of the questions that we must answer.

Insects

The future importance of entomology in all agricultural fields is not in doubt. Forest entomology will hold an even more important place in future forestry programs. As time will increase the intensity of forest practices, so will time increase demands for protection of forests and forest products from insect attack.

To list the unanswered entomological questions facing the Coeur d'Alene Laboratory would be a most difficult task. The region's many timber types and destructive insects that are indigenous to the area result in a great number of economic problems. An analysis of these problems would show that entomologists must know with assurance when to do bark beetle control. Even with aerial spraying, the forest manager must be shown how to live with forest defoliating insects. Entomologists must show land managing agencies how to establish and maintain insect resistant timber stands. They must demonstrate how to harvest one tree species from a mixed forest without causing subsequent damage to the residual stand. They must be constantly working toward the improvement or replacement of known methods of control. Above all, control methods must be cheap as well as effective.

Diseases

Tree diseases, like insects, are invariably present in a forest, usually in an endemic state. As forest management operations increase in extent and frequency in the future we will create more and more imbalances in natural environmental conditions. The effects of these changes on populations of disease organisms must be known if we are to prevent their building up to damaging proportions. The pathologist must learn much about diseases in relation to environment so that he can tell the silviculturist how to avoid pathological problems.

It is, of course, impossible to foresee what new diseases, like pole blight of white pine, may arise to add to future management problems. However, much research is still needed to solve such long-standing problems as the dwarf mistletoe on lodgepole pine and western larch, the heart rots of hemlock and grand fir, and the Christmas tree blight. Studies in logging damage and brush disposal and pathological revision of the present marking rules for all timber types in this region would materially aid forest managers in the future.

Basic Resource Data

Intensive management and the planning it requires cannot proceed without sound statistical data on the timber resource, its location, extent, growth, and industrial use. A good start has been made in the region in assembling basic timber resource data, but in the years ahead this material must be kept up to date, improved, and localized. In the northern Rockies, we are just beginning to move into an era of diversified and expanded industrial development, of emphasis on the value of the water resource, and of intensive forest management. In the past, forest industries have relied heavily on white and ponderosa pines and forest development has been along the fringe instead of reaching back into the remote areas. The situation is changing.

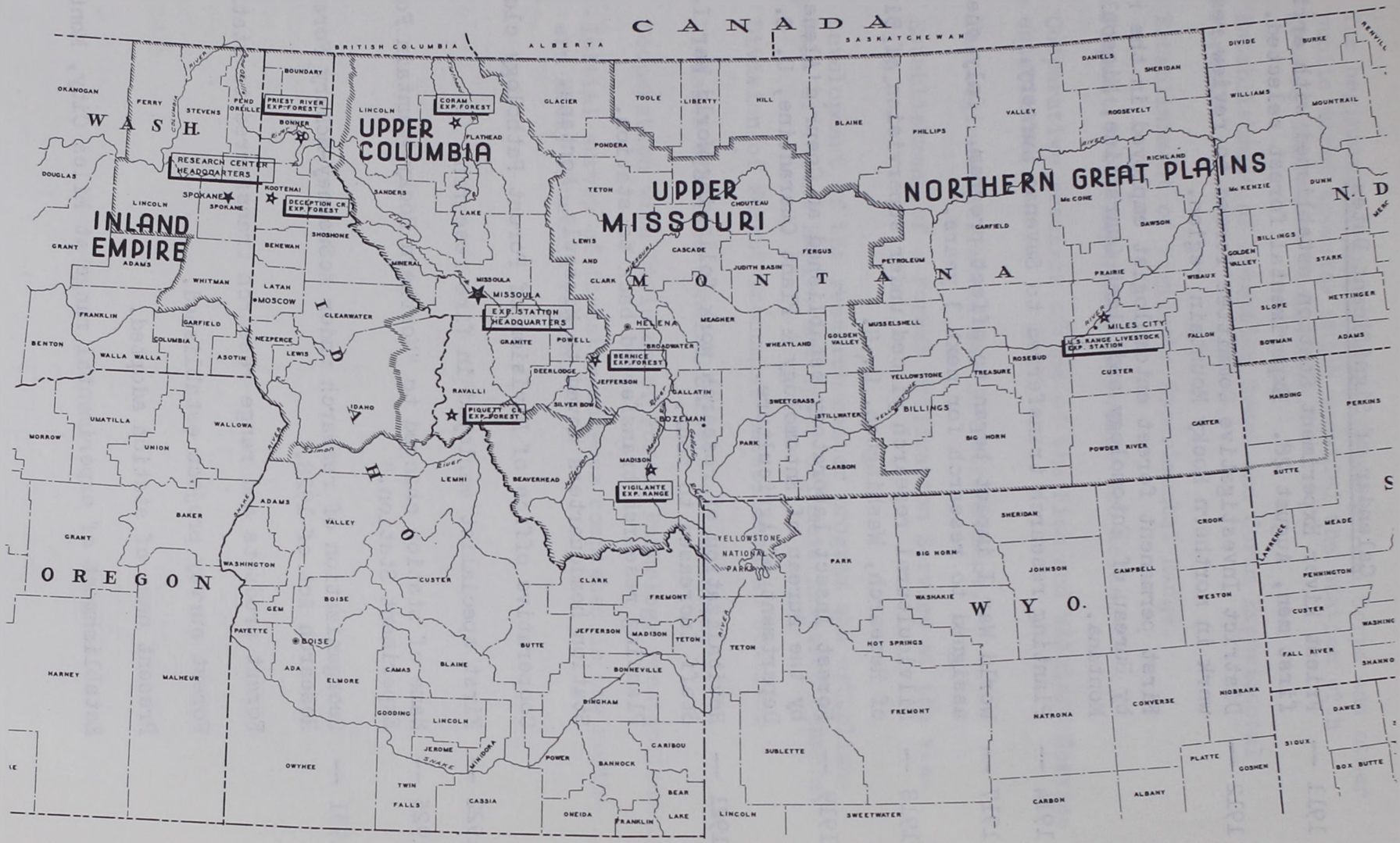
Because of the strong demand for timber some forest areas previously considered noncommercial must be reclassified for they are now being or will be logged. New markets such as for pulpwood are increasing utilization and making more timber marketable. Construction of access roads is opening up remote areas. Lumber production has gained steadily in recent years and the pole industry is shifting from cedar to lodgepole, western larch, and Douglas-fir. The result is that the present resource data are fast becoming obsolete and an expanded program of resource surveys will be needed to meet the current and probable future demand for timber resource data. One of the most pressing needs is to localize the timber resource data so that areas having excess timber can be isolated from areas where over-cutting may be prevalent.

So, as we come to the end of forty years of forestry research we feel proud of the accomplishments of the station. We can't be satisfied, though, until we come to grips with the many complex problems yet unsolved. They will be quite different problems, to be sure -- different from those that faced the first wagonload of stalwarts who started a research program at Priest River in 1911. Our main concern of the future will be to get answers to more fundamental questions. In the northern Rocky Mountain region we have grown out of the exploitation and custodial eras in the last forty years. We look ahead to an era of more intensive management and one in which timber, forage, and water use will have to be highly integrated. We feel confident research can contribute much to full and wise resource use.

APPENDIX

RESEARCH CENTER BOUNDARIES AND EXPERIMENTAL FORESTS AND RANGES

NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION



Calendar of Significant Dates

1911 -- Priest River Experiment Station established with arrival of first men, August 28. Experimental forest selected.

1912 -- District Investigative Committee formed to review research work in northern Rocky Mountain region.

First permanent forest entomologist employed in the region by Bureau of Entomology and Plant Quarantine, Missoula, Montana.

1914 -- Planting research transferred to Savenac Nursery.

1917 -- World War I impact began to affect program. Only one man assigned to research for next 3 years.

1918 -- Silvicultural research placed under supervision of Director of Research, Washington, D. C.

1919 -- Forest Insect Laboratory established at Coeur d'Alene, Idaho, by the Bureau of Entomology & Plant Quarantine, U. S. Department of Agriculture.

1921 -- Revitalization of research work following World War I. Staff increased to four.

Planting research transferred back to station.

Station headquarters moved to Missoula, Montana.

Cooperative office of Division of Forest Pathology closed.

1922 -- First specialist employed in fire research.

1925 -- Name of station changed to "Northern Rocky Mountain Forest Experiment Station."

1931 -- Reorganization of research under McSweeney-McNary Forest Research Act of 1928.

Forest products and range research transferred to station.

Forest survey project established.

Present name of station adopted.

Establishment of experimental range at Miles City, Montana.

1933 -- The beginning of the Civilian Conservation Corps and other public works agencies which provided the station with greatly increased facilities.

Establishment of Deception Creek and Coram Experimental Forests.

1935 -- Establishment of Vigilante Experimental Range.

1939 -- Piquett Creek Experimental Forest set aside.

1941 -- Cooperative research office of the Fish and Wildlife Service established.

1942 -- The beginning of World War II retrenchment.

1945 -- Establishment of a Forest Utilization Service at the station.

1946 -- Development of the research center program and establishment of Inland Empire and Upper Columbia Research Centers.

Division of Forest Economics established at station.

1948 -- Division of Flood Control Surveys established.

Cooperation with Division of Forest Pathology reestablished.

1950 -- Initial survey of forest resources completed in the northern Rocky Mountain region.

Directors of the Northern Rocky Mountain Forest and Range Experiment Station

1911 - 1917	Donald R. Brewster
1918 - 1920	James A. Larsen
1921 - 1930	Robert H. Weidman
1931 - 1936	Lyle F. Watts
1936 - 1938	Stephen N. Wyckoff
1939 - 1946	Melvin I. Bradner
1946 - 1950	Charles L. Tebbe
1950 -	George M. Jemison

Number of Publications Issued by the Station, 1911 to 1950

Printed bulletins	31
Technical journal articles	345
Station notes *	206
Station papers	64
Processed reports	80
Total	726

* Includes Research Notes, Applied Forestry Notes, Hi-Lites, and miscellaneous publications.

Major Accomplishments During 1950

The station is proud of its safety record of 1950 - a full year without a lost-time accident. Approximately 57 man years of work performed during the past year without any time lost from accidents is considered a noteworthy accomplishment.

High light accomplishments in the technical fields follow.

Forest Management Research

1. The station made substantial progress in activating a program of forest genetics. Major steps included the following:

   (a) Sent a man to the Institute of Forest Genetics at the California Forest and Range Experiment Station where he received instruction in the specialized skills of artificial pollination of coniferous trees. As a result, the station now has a staff member who can practice controlled pollination.

   (b) In cooperation with the Division of Blister Rust Control, assisted in cross-pollinating about 50 native white pine trees which appear to be highly resistant or immune to blister rust. Development of a blister rust resistant strain of white pine might eventually eliminate much of the need for other types of blister rust control.

   (c) Organized a regional forest genetics steering committee, composed of representatives from universities, agricultural experiment stations, and federal agencies, which may assist in the discovery or propagation of faster growing, disease resistant, and otherwise superior trees. The purposes of the committee are to correlate work, prevent duplication of effort, and promote understanding of tree breeding.

2. The station completed its portion of the Spokane Pine Damage Committee study and reported its findings at a meeting of the Northwest Scientific Association. The study showed that diameter growth of ponderosa pine had been abnormally reduced in the north Spokane area in contrast to the growth pattern on trees at a distance from the affected district. The growth reduction a) was found to be located around an area where industrial fumes are created, and b) was not correlated with variations in rainfall.

3. As another step in the station's program for study of pole blight, plots were established which will test the effect of salvage cutting on further development of pole blight in an affected white pine stand. Marking and measurement of the trees were completed and before the end of the year a timber sale contract for the cutting had been awarded. The University of Idaho, Division

of Forest Pathology, and Kaniksu National Forest are working cooperatively on this project.

4. Timber sales contracts were awarded for volumes of timber ranging from 1,570,000 board feet to 1,885,000 board feet on the Coram, Deception Creek, and Priest River Experimental Forests in order to carry out large scale silvicultural experiments. The Coram sale will test several cutting and seedbed preparation methods in the larch--Douglas-fir type, and the Deception Creek sale will test two methods of blister rust control. The Priest River sale will serve partly as a demonstration of a cutting practice and partly for testing slash disposal methods in cooperation with the University of Idaho. The Deception Creek contract, which was awarded on competitive bid, set a new high price for western white pine -- $41.52 per thousand board feet, including a sale area betterment payment of $3.40.

5. Preliminary results from experiments with slash disposal and seedbed preparation methods in lodgepole pine clear cuttings indicate that bunching slash with a bulldozer slash piler is an effective and cheap method. Machine bunching and burning reduced the fuel rating from H-M (high rate of spread, medium resistance to control) to M-L (medium rate of spread, low resistance to control) or its near equivalent, L-M. The direct costs (machine rental and operator wages) of machine bunching and burning amounted to $9.06 per acre in the experiment -- an acceptably low figure. Prescribed broadcast burning cost only $2.06 per acre and reduced the fuel rating to L-M, or L-L, but resulted in much less satisfactory natural regeneration. On the basis of stocking by milacre quadrats, burned surfaces on north slopes were stocked only 12 percent after one growing season in contrast to 74 percent stocking where the mechanical slash buncher had removed slash and scarified the ground surface. On the south slopes, burned surfaces were found to be 35 percent stocked and scarified surfaces, 96 percent.

6. An 11-acre accidental broadcast burn of lodgepole pine slash was successfully direct seeded. Prior to seeding, the burn and surrounding area were baited with thallium-sulphate-treated sunflower seed by the Fish & Wildlife Service to reduce the rodent population. Lodgepole pine seed was planted by the seed-spotting method early in June when the area became free of snow. In September, at the end of the first growing season, 74 percent of the seed spots contained one or more seedlings, with an average of 3 seedlings per spot. The test demonstrated that the direct seeding method, worked out by the station in previous years, is applicable to the lodgepole pine type. The chief requirements for direct seeding in the northern Rockies are 1) absence of seed-destroying rodents, 2) absence of vegetational competition, 3) sites which are not subjected to severe drying, such as north slopes and flats, and 4) favorable weather during the first growing season.

Range Research

1. The 18-year-old study of cattle grazing intensity, conducted at Miles City in cooperation with the Montana Agricultural Experiment Station and the Bureau of Animal Industry, was modified and reoriented for indefinite continuation. Plans were made for rotating the heifer offspring back into the experiment and more intensive studies of range vegetation and soils were planned.

2. Additional information on the effects of hauling and trailing cows and calves to summer range was obtained. Cows lost about the same weight whether trailed or hauled. Calves lost 10 pounds per head (6 percent of their ranch weight) by trailing but nothing in a 60-mile haul. Trailing and hauling appeared to have no noticeable effect on summer gains.

3. Research in the control of noxious range plants was continued.
   (a) It was found that sprays of 2,4-D (6,000 to 10,000 ppm.) in water or diesel oil give a complete kill of Wyethia in one season. The oil carriers reduced other vegetation 1.5 percent but increases of 6.5 percent occurred where water-carried sprays were used. Similar tests on tall larkspur were unsuccessful.

   (b) Cooperation in noxious range plant research was extended to include the University of Idaho and the Montana Extension Service. Assistance was given by division personnel in guiding general public interest in goatweed control into the organization of the Western Montana Committee on Weed Control which is now active in stimulating research and control programs.

4. Work in range reseeding during 1950 was primarily confined to extending species adaptation studies and developing grazing trials of reseeded species. Three new forage species adaptation nurseries were established, two in northeastern Washington and one on the Fort Missoula area. Two series of pastures were laid out and seeded to improved forage species for future use in determining grazing values of reseeding species.

5. Extension activities were prominent in 1950. More than 500 visitors in 15 organized groups were conducted on show-me tours of cattle grazing experiments and other range phases of the research program at the United States Range Livestock Experiment Station during the year. Division personnel participated as instructors at two range schools, one conducted for college credit by Montana State College, the other mainly for federal agency personnel at the University of Idaho.

Forest Utilization Service

Our Forest Utilization Service worked closely with industrial concerns

and other groups throughout the year and assisted in achieving the following:

1. Satisfactory wall board was produced by a local company from pole shaving waste on a pilot plant scale. The board that was developed has strength comparable to other fiber boards and has high decorative properties. It can also be used as a sheeting or plaster base.

2. Development of wood sugar molasses as a livestock feed progressed beyond the experimental stage. In cooperation with Montana State College and livestock feed producers of the State of Montana, a plan was developed for 1) Montana feed dealers to process 500,000 tons of feed using wood sugar molasses as a carbohydrate substitute, and 2) Montana stockmen to feed this material to cattle and sheep under actual range conditions.

3. We cooperated with Montana State College in testing lignin as a soil conditioner in greenhouse soils. Tests showed a 25 percent increase in the weight of blooms on chrysanthemum plants grown on soil to which lignin had been added.

4. Three sawmill demonstrations, attended by 150 operators of small sawmill equipment and other interested individuals, were staged in western Montana in an effort to increase the quality of lumber produced.

5. Arrangements were made for Swiss contractors to test the Wyssen cable logging equipment on an Engelmann spruce operation in the Flathead National Forest in an effort to develop better methods for logging difficult terrain.

6. Inaugurated the successful use of sawdust as a soil conditioner on irrigated sugar beet lands of the Bitterroot Valley, resulting in improvement of the physical condition of the soil and higher sugar content of the beets.

7. Developed the annual program for the Northwest Wood Products Clinic on the subject of associated species. This program directed nationwide attention to the properties and characteristics of lumber produced from lodgepole pine, larch, white fir, and species other than ponderosa pine and Idaho white pine.

Forest Economics

Forest Survey, initial phase

1. A plan for carrying on the survey in South Idaho was prepared and is ready to be used when funds are available. The plan calls for work to be initiated in four counties: Bannock,

Bonneville, Madison, and Teton. In these counties various methods for sampling and making type maps to meet forest survey standards are to be investigated.

2. In eastern Montana, where field work was completed in 1949, the last of the unit statistical reports was released as Station Paper 23. This report, "Forest Resources of South Central Montana," gave forest area and timber volume statistics for nine south central counties.

3. A comprehensive statistical report, "Montana Forest Resource and Industry Statistics," was released as Station Paper 25. This summarized the pertinent forest resource and industry data collected by the forest survey in Montana for the past 15 years. The report included a state-wide colored map showing the major forest types.

4. A draft of a forest survey analytical report for the State of Montana was submitted to a board of review. This report includes state-wide data on the timber resource and analyzes the data from the standpoint of the impact of the present resource situation and forest practices on the future of the forest productivity. It points out possibilities for expanding forest industries and what is needed in terms of a development program to maximize timber yields.

Forest Survey, resurvey phase

1. Field inventory and computation of data for the North Idaho resurvey continued during the year. Field work was centered in Idaho County and office work included all counties. About one-half million acres of forest land remains to be covered to complete field work for the resurvey in North Idaho.

2. Industry surveys covering commodity production and timber drain were made for poles, pulpwood, and Christmas trees. These surveys showed the following:

	Commodity production 1948	1949	Percent chage
Poles (no. pieces)	447,986	599,312	+34
Pulpwood (no. cords)	88,530	113,570	+28
Christmas trees (no. trees)	3,098,886	3,256,956	+ 5

Economics of Forest Management, Utilization, and Marketing

1. The study of Christmas tree marketing problems in Montana was completed with the publication of "Marketing Montana Christmas Trees." The bulletin, one of a series being published by the Forestry School, Montana State University, is a comprehensive

treatise on the Christmas tree industry marketing situation. It points out that unless aggressive corrective measures are taken by the industry markets for Montana, trees are likely to decline in the period ahead. Adoption of grading rules, strengthening of grower associations, and trade promotion are recommended.

2. A project analyzing the feasibility of a pulpmill industry in eastern Montana was initiated. This project will include study of the extent and location of the timber resource in eastern Montana, representative manufacturing locations, pulpwood transportation problems, suitability of the timber, relation of a pulpmill industry to other industries, the effect of the ownership pattern on timber use, and the allowable cut of timber products.

Forest Fire Research

Fire Behavior

1. A complete outline for a publication to be entitled "Fire Behavior in Northern Rocky Mountain Forests" was prepared and sent to a board of review. A large amount of data and background material were collected.

2. An experimental model of a rate-of-spread computer was designed, and several were field tested on ranger districts on various national forests.

3. Five fire behavior schools were conducted in cooperation with the Regional Division of Fire Control. These schools were attended by one or more representatives from each ranger district in the region and by all smokejumpers. A series of lantern projection slides illustrating pertinent features of fire behavior were prepared for use in these schools.

4. Analysis of some 22,000 Forest Service fire reports indicated the need for a revision of the fuel rate-of-spread classification to better indicate the danger in flashy fuels such as grass and continuous fine fuels found in some logging slash areas. Accordingly, recommendations were prepared for a new classification system involving five rather than four rate-of-spread types. In addition some tentative fuel classification keys were prepared to simplify identifcation of the various types.

Fire Danger Rating

1. Studies of large log fuel moisture and condition of herbaceous vegetation were continued at the Priest River Experimental Forest. At the end of the year an analysis of data collected to date from the large log experiments was begun. The results of these studies will be used to improve the rating of seasonal fire danger build-up.

2. Fuel moisture stick manufacture was continued at Priest River. Some 2,000 sets of sticks were manufactured during the summer for use by all forest protection agencies in the western United States.

3. The annual rating of the 1950 fire season was prepared, and in addition a summary of fire danger rating for the past 17 years was compiled. The 1950 season was the second easiest on record.

Fire Control

1. An analysis of 36,000 forest fire reports was completed. A manuscript, now in final form, entitled "Forest Fires in the Northern Rocky Mountains" will be issued in 1951.

2. During 1950 a comprehensive analysis was made of the combined air-ground detection systems now being operated on several national forests. This analysis provided information regarding the efficiency of patrol aircraft and lookouts as well as other data required in detection planning.

3. An analysis was completed of all fires receiving smokejumper action during the period 1940-1949. Maps were prepared showing the location of all smoke jumper fires. This analysis should provide valuable background material for future work in fire control planning research.

4. Cooperation was continued with the University of Idaho and the Division of Forest Management Research in slash disposal studies. Basic data on slash fires were provided workers on the University of Idaho project.

Flood Control Surveys

1. Cover type and condition data, from the standpoint of watershed characteristics, were compiled for four of seven tributary areas for which hydrological and economic analyses are to be made. Forest Survey information, used as a base, was reclassified and supplemented by data on ground cover, slope, elevation, litter, humus, use, and other factors.

2. A reconnaissance type of soil survey was made on the four watersheds mentioned above. Geological formation and physiography were the two most important criteria for classification. Emphasis was on factors reflecting soil-water relationships. Classification was difficult because the soils are young and undeveloped geologically, and because of the absence of secondary sources of information. Areas of glacial action presented special problems.

3. Collection of flood damage data was started. Most of the effort was in securing and reviewing secondary sources,

particularly files of the Corps of Engineers. Progress has been made in obtaining information on damage to national forest lands and improvements.

4. Flood Control Surveys personnel have worked aggressively with regional men in describing projects and measures, preparing standards and objectives, and determining costs and man-day requirements for flood control plans and Columbia Comprehensive Plan purposes.

5. Snow studies at the Priest River Experimental Forest were continued with some modifications. Field work was completed on the altitude-aspect plots; preliminary figures reflect differences in snow conditions by elevational zones and direction of exposure. One year's record was completed on comparison of precipitation catches in four types of measuring gages installed on windswept sites. Results are being prepared for publication. The Benton Spring installation was improved so that a continuous flow record is now being obtained. The installation of about 90 soil moisture-temperature units was completed in the early part of the year. These are located at various soil depths in seven different locations.

6. Unusual snow conditions prior to the melt season led to snowmelt studies in three mountain-top areas. Known as "Operation Snow Pack," this work was undertaken in an effort to gain additional information on snow behavior under various cover, aspect, and weather conditions. Melt conditions were such that the anticipated high water or flood runoff did not develop. A report is being prepared.

7. In cooperation with the Region, the Division received late-season readings on 25 or 30 regular cooperative snow courses. The readings were taken at 2-week intervals from time of maximum accumulation until melting was complete. In addition to the above, a few low-elevation courses and courses in brush areas were established and measured.

Wildlife Research
(In cooperation with the Fish and Wildlife Service)

1. Certain phases of a 4-year study of deer in relation to ponderosa pine plantations was completed on the Kootenai National Forest. Among findings to be published soon is the outstanding fact that in 3 years deer destroyed nearly 40 percent of the trees planted on 7 experimental plots.

2. A study of the consumption of ponderosa pine seed by small mammals showed that white-footed mice and chipmunks eat large numbers of pine seed. An abundant natural crop of seed was reduced by the rodents to a level which was inadequate for restocking the cut-over area.

3. Three contributions were made to the wildlife literature on statistical methods. Papers were published on a punch-card technique for handling wildlife data and on the use of biometry in wildlife research. A manuscript was completed on confidence limits for the Lincoln Index, a technique for wildlife inventory.

Forest Pathology Research
(In cooperation with the Division of Forest Pathology)

Pole blight research has been underway for about two years. Early results during 1950 were:

1. A manuscript was completed summarizing the early results of Scopularia inoculations on white pine. After one year, inoculated trees showed lesions with associated resinosis resembling those on pole blighted trees but no foliage or crown deterioration. Additional inoculations of Scopularia on tree species associated with white pine have been made.

2. The initial pole blight survey and mapping job was completed in the region except for the Cabinet National Forest.

3. Further tests of the effects of fertilizers on pole blighted stands were established.

Publications Issued During 1950

Adams, Lowell
Consumption of ponderosa pine seed by small mammals. Research Note no. 80. March 1950.

_____
A punch-card system suitable for use with small samples in wildlife management and research. Fish & Wildlife Service Special Scientific Report--Wildlife No. 3. April 1950.

Anderson, I. V.
Forest products industries of Montana. Montana Business, vol. 2, no. 9. September 1950.

Dickerman, M. B.
Pole production gains in 1949. Research Note no. 83. May 1950.

_____
Pulpwood cutting continues to increase. Research Note no. 84. May 1950.

_____
The meaning of conservation. Proc. Western Farm Economics Assoc. June 1950.

_____
Review: Small town renaissance, by R. W. Poston. Jour. Forestry, p. 895. December 1950.

Division of Range Research
The northern great plains research center, its work and aims. Misc. Sta. Pub. no. 1. May 1950.

Evanko, A. B.
A tin can infiltrometer with improvised baffle. Research Note no. 76. February 1950.

Finch, T. L., Hodge, W. C., and Metcalf, M. E.
Forest resources of south central Montana. Station Paper no. 23. April 1950.

Foiles, Marvin W.
Recommendations for poisoning western hemlock. Research Note no. 77. February 1950.

Gisborne, H. T.
Tests show cigar and cigarette stubs come down hot. Fire Control Notes 11(2):28-29. April 1950.

Harris, G. A.
A selected bibliography of range management literature published in 1949. Bibliography, v. 1, no. 4. September 1950.

Hodge, William C.
Using air photo methods for timber surveys in the northern rocky mountains. Paper presented at Northwest Scientific Assoc. meeting. December 1950.

Huey, Ben M.
Montana Christmas tree shipments high again. Research Note no. 82. March 1950.

_____
The profit in pruning western white and ponderosa pine. Research Note no. 85. July 1950.

_____
The profit in pruning western white and ponderosa pine. The Timberman LI(11):62, 64-65. September 1950.

_____
Christmas tree harvest. Spokesman-Review. December 17, 1950.

_____ and Hutchison, S. Blair
Marketing Montana Christmas trees. Montana State Univ., Sch. Forestry bull. 2. December 1949.

Hutchison, S. Blair
Fifty years of forestry in the U.S.A. Chapter 11. Other federal agencies. Soc. of American Foresters. 1950.

Kemp, Paul D. and Dickerman, M. B.
Montana forest resource and industry statistics. Station Paper no. 25. October 1950.

Meik, E. E.
A cost-benefit analysis of seeding abandoned farm land to crested wheatgrass by the preparatory crop method. Jour. Range Management, 3(3):190-197. July 1950.

Peiffer, A.
Evolution of the fire danger meter. American Forests 56(4):12-13, 36. April 1950.

Peterson, R. A.
Book review: birds of the west. Scientific Monthly, LXXI(4): 282. October 1950.

Rapraeger, E. F.
The cubic foot as a national log-scaling standard. Station Paper no. 24. (Reissue of January 1940 report.) June 1950.

Roe, Arthur L.
Response of western larch and Douglas-fir to logging release in western Montana. Northwest Science XXIV(3):99-104. August 1950.

_____ and Boe, Kenneth N.
Ponderosa pine bibliography. Station Paper no. 22. March 1950.

_____ and Squillace, A. E.
Can we induce prompt regeneration in selectively-cut ponderosa pine stands? Research Note no. 81. March 1950.

Squillace, A. E. and Adams, Lowell
Dispersal and survival of seed in a partially-cut ponderosa pine stand. Research Note no. 79. March 1950.

Watt, Richard F.
Growth in understocked and overstocked western white pine stands. Research Note no. 78. March 1950.

_____
Approach toward normal stocking in western white pine stands. Northwest Science XXIV(4):149-157. November 1950.

Departmental Publications Planned for F.Y. 1951

Barrows, J. S.
Fire behavior in northern rocky mountain forests. (Approximately 100 typed pages.) To be printed in agricultural handbook series.

Hurtt, L. C.
Managing northern great plains cattle range to minimize effects of drought. To be issued as U. S. D. A. circ. no. 865.

Hutchison, S. Blair and Kemp, Paul D.
Forest resources of Montana. (Approx. 80 printed pages.) To be issued as a U.S.D.A. Forest Resource Report.

Departmental Publications Planned for F.Y. 1952

Holscher, C.E. and Woolfolk, E. J.
Conservative forage utilization - a key to efficient cattle production. (Approx. 30 printed pages.) For a U.S.D.A. circular.

Reed, M. J. and Peterson, R. A.
Response of cattle and range to stocking rate in northern great plains. (Approx. 120 typed pages, including charts and figures.) To be issued as a technical bulletin.

Roe, Arthur L.
Growth in selectively-cut ponderosa pine in the upper Columbia basin. (Approx. 25 printed pages.) For a U.S.D.A. miscellaneous publication (handbook).

Short, L. R. and Woolfolk, E. J.
Reseeding to increase the yields of Montana range lands. Revision of Farmers' Bull. 1924 issued in February 1943. Approx. 26 printed pages.

Wellner, C. A.
Silvicultural management of the western white pine type. (Approx. 60 printed pages.) For a technical bulletin.

Other Publications Planned for Release During 1951

Adams, Lowell
Fifty years of porcupine cycles. For Journal of Mammalogy.

_____
White-tailed deer browsing on ponderosa pine plantations. For research note.

Anderson, I. V.
Suitability of Engelmann spruce and other rocky mountain woods for violins. For a research note.

_____
Lignin for golf greens and other horticultural uses. For a research note.

Barrows, J. S.
Forest fire research in the northern rocky mountains. For a station paper.

_____
Lightning fires in the northern rocky mountains. For Fire Control Notes.

_____
Fuel classification and danger rating sections, Foresters' Field Handbook. Soc. American Foresters.

_____
Forest fires in the northern rocky mountains. For a station paper.

Boe, K. N.
Preliminary results of slash disposal and seedbed preparation on lodgepole pine regeneration. For a research note.

Davis, K. P., Moss, V., and Wellner, C. A.
Blister rust in the management of western white pine. Revision of station paper no. 3.

Dickerman, M. B.
Status and trend of forest resource and industry. Scope and method report. Soc. American Foresters.

_____
Pole production trends. For a research note.

Finch, Thomas L.
How fast is timber growing in eastern Montana? For a research note.

Flood Control Surveys
Precipitation measurement on wind-swept slopes. Paper presented by Austin E. Helmers at meeting of Forestry Sec., Northwest Scientific Assoc., Spokane, Wash., December 1950. To be published in Northwest Science, and possibly in Transactions of American Geophysical Union.

Flood Control Surveys
Forest fire - summer rain - watershed knockout combination. For a station paper, and possibly in American Forests.

_____
Some results of operation "snow pack, 1949-50." For a research note.

_____
Design, operation and use of a small ring infiltrometer. For a research note.

_____
Influence of altitude and aspect on snow accumulation and melt. For a station paper.

_____
Some effects of forest cover on the interception and melting of snow. For a station paper.

_____
Precipitation and runoff in a small forested watershed. For a station paper.

_____
Some meteorological factors affecting snow melt. For a station paper.

_____
An anemohygrothermograph. For a research note, and possibly in Journal of Forestry, Briefer Articles & Notes.

_____
Response of a mountain spring to precipitation and snow melt. For a research note.

_____
A few soil moisture and temperature cycles. For a research note.

_____
Snow studies across a mountain valley. For a station paper.

Foiles, M. W.
Results of direct seeding with germinated western white pine seed. For a research note.

_____
Results of poisoning western hemlock. For Montana Academy Science.

Forest Genetics Steering Committee
Specifications for selection of superior parent trees.

Gill, Lake S., Leaphart, Charles D., and Andrews, Stuart R.
A preliminary note on the ability of Scopularia (Leptographium) sp. to produce lesions in western white pine. For a Bureau multilith.

Harris, Grant A.
Adaptation of grass species in Ferry County, Washington. For a research note.

_____
St. Johnswort on western ranges. For a station paper.

_____
The influence of precipitation on yield and culm production of certain southwestern Montana range grasses. For Journal of Forestry.

_____
Growth and development of three important grasses. For Ecology.

Hodge, William C.
Using air photo methods for timber surveys in the northern rocky mountains. For Northwest Science.

Huey, Ben M.
Christmas tree shipments decrease. For research note.

_____
Mine timber production in the northern rockies. For a research note.

Hutchison, S. Blair
Economic evaluation of public insect and disease control programs. Soc. American Foresters. Scope and method report.

_____
A yardstick for judging public forestry projects. For Journal of Forestry.

LeBarron, R. K., and Wellner, C. A.
Prevention instead of cure for blister rust. For American Forests.

Lyman, C. K., and Barrows, J. S.
Rate-of-spread classification for northern rocky mountain fuels. For Fire Control Notes.

Lynch, Donald W.
The influence of stocking and site on diameter growth of second-growth ponderosa pine. For Northwest Science.

Lynch, Donald W., and Chapman, R.
Sampling in tree measurement sales on northern region national forests. For station paper.

Metcalf, M. E.
Mortality trends in eastern Montana. For research note.

_____ and Kemp, Paul D.
Forest resource statistics for North Idaho. For station paper.

Mueller, L. A.
Suitability of western larch for veneer and plywood production. For research note.

Northern Rocky Mountain Station
List of publications available for distribution or loan. Revision of station paper no. 14.

Polk, R. Brooks, and Boe, K. N.
Succession of trees in cut-over larch-Douglasfir stands in western Montana. For Montana Academy Science.

Reed, M. J., and Peterson, R. A.
Some effects of grazing intensity on growth of northern great plains range grasses. For Jour. of Range Management.

Roe, A. L.
Tables for predicting growth in selectively-cut ponderosa pine stands. For station paper.

_____
Tables for predicting growth in selectively-cut stands in larch-fir type. For station paper.

Short, L. R.
Plant heights as indicators of range condition. For Jour. of Range Management.

Watt, Richard
Severe winter damage in a pole stand of the western white pine type. For Research Note.

Wellner, C. A., and Foiles, M. W.
Guide to Deception Creek Experimental Forest. For station miscellaneous publication.

_____, Watt, R. F., and Helmers, A. E.
Guide to Priest River Experimental Forest. For station miscellaneous publication.

Wikstrom, John H.
Pulpwood production trends. For research note.

Woolfolk, E. J.
The grazing value of crested wheatgrass. For American Cattle Producer.

Personnel of Station - December 31, 1950

OFFICE OF DIRECTOR

George M. Jemison	Director
Mary J. Pershina	Administrative Assistant
S. Dagmar Nelson	Clerk
Marie Van Loon	File Clerk
Dorothy A. Peete	Clerk-stenographer

DIVISION OF FOREST MANAGEMENT RESEARCH

Russell K. LeBarron (Chief)	Forester (For. Man. Res.)
Grace D. Ehlers	Clerk-stenographer

DIVISION OF RANGE RESEARCH

E. Joseph Woolfolk (Chief)	Range Conservationist
Laurence R. Short	Range Conservationist
Roald A. Peterson	Range Conservationist
Merton J. Reed	Range Conservationist
Anthony B. Evanko	Range Conservationist
Mary C. Bowler	Clerk-stenographer

DIVISION OF FOREST ECONOMICS

Murlyn B. Dickerman (Chief)	Forest Economist
S. Blair Hutchison	Forest Economist
Paul D. Kemp	Forest Economist
Ben M. Huey	Forester (For. Man. Res.)
Thomas L. Finch	Forester (Mensuration)
William C. Hodge	Forester (Mensuration)
Melvin E. Metcalf	Forester (Mensuration)
John H. Wikstrom	Research Forester
Henry J. Pissot	Forestry Aid (Research)
Monica E. Hobe	Clerk-stenographer
Ilo D. Hendricksen	Clerk-stenographer

DIVISION OF FLOOD CONTROL SURVEYS

Martin E. Baudendistel (Chief)	Forester (For. Inf.)
Paul A. Ingebo	Hydrologist
Norman R. Tripp (trans. to N.E. Exp. Sta. 1-15-51)	Forester (For. Inf.)
C. Allan Friedrich	Forester (For. Inf.)
Austin E. Helmers	Forester (For. Inf.)
Gordon A. Hutton	Forester (For. Inf.)
DeWilton C. Smith	Research Forester
Richard J. Alvis	Soil Scientist
Ludvik Rosich	Physical Science Aid
Onnolee A. Peffer	Clerk-stenographer

FOREST UTILIZATION SERVICE

Irvin V. Anderson (Chief)	Forester
Lincoln A. Mueller (trans. to S.W.Exp. Sta. 1-1-51)	Forester
Hilda C. Griffiths	Clerk-stenographer

DIVISION OF FOREST FIRE RESEARCH

Jack S. Barrows (Chief)	Forester (Fire Res.)
Edna H. Campbell	Clerk-stenographer

INLAND EMPIRE RESEARCH CENTER

Charles A. Wellner (Research Center Leader)	Forester (Res. Adm.)
Donald W. Lynch	Research Forester (Gen.)
Grant A. Harris	Range Conservationist
Marvin W. Foiles	Forester (Silv.)
Richard F. Watt	Forester (Silv.)
Florence R. Olson	Clerk-stenographer
T. S. Buchanan (University of Idaho)	Collaborator

UPPER COLUMBIA RESEARCH CENTER

Arthur L. Roe (Project Leader)	Forester (Silv.)
Kenneth N. Boe	Forester (Silv.)
Anthony E. Squillace	Forester (Silv.)

FIELD STATIONS

Deception Creek Experimental Forest, Coeur d'Alene, Idaho,
Marvin W. Foiles, In Charge
Priest River Experimental Forest, Priest River, Idaho
Austin E. Helmers, In Charge
Coram Experimental Forest, Coram, Montana
Anthony E. Squillace, In Charge
Northern Great Plains, Miles City, Montana
Laurence R. Short, In Charge
Vigilante Experimental Range, Alder, Montana
Anthony B. Evanko, In Charge

FOREST PATHOLOGY (In cooperation with Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering): Charles D. Leaphart, Missoula, Montana.

FOREST WILDLIFE (In cooperation with Fish and Wildlife Service, Department of Interior): Lowell W. Adams, Missoula, Montana.

INSECT CONTROL (In cooperation with Bureau of Entomology and Plant Quarantine): James C. Evenden, Coeur d'Alene, Idaho.

DIRECT AND INDIRECT COSTS BY FINANCIAL PROJECTS

F. Y. 1951

Financial Project	Indirect	Direct	Total
Forest & Range Management Inv.	$19,258 *	$139,062	$158,320
Forest Products Inv.	1,911	18,639	20,550
Forest Resources Inv.	5,533	53,967	59,500
Flood Control Surveys	6,860	67,354	74,214
Total	33,562	279,022	312,584

* Includes $5,000 for Hurtt's salary and expenses.

Contents

	Page
Major Accomplishments During 1950	1
Forest Management Research	1
Range Research	3
Forest Utilization Service	4
Forest Economics	4
Forest Fire Research	6
Flood Control Surveys	7
Wildlife Research	8
Forest Pathology Research	9
Publications	10
Publications Issued During 1950	10
Departmental Publications Planned for F.Y. 1951	12
Departmental Publications Planned for F.Y. 1952	12
Other Publications Planned for Release During 1951	13
Finance	18
Personnel	20

Major Accomplishments During 1950

The station is proud of its safety record of 1950 - a full year without a lost-time accident. Approximately 57 man years of work performed during the past year without any time lost from accidents is considered a noteworthy accomplishment.

High light accomplishments in the technical fields follow.

Forest Management Research

1. The station made substantial progress in activating a program of forest genetics. Major steps included the following:

   (a) Sent a man to the Institute of Forest Genetics at the California Forest and Range Experiment Station where he received instruction in the specialized skills of artificial pollination of coniferous trees. As a result, the station now has a staff member who can practice controlled pollination.

   (b) In cooperation with the Division of Blister Rust Control, assisted in cross-pollinating about 50 native white pine trees which appear to be highly resistant or immune to blister rust. Development of a blister rust resistant strain of white pine might eventually eliminate much of the need for other types of blister rust control.

   (c) Organized a regional forest genetics steering committee, composed of representatives from universities, agricultural experiment stations, and federal agencies, which may assist in the discovery or propagation of faster growing, disease resistant, and otherwise superior trees. The purposes of the committee are to correlate work, prevent duplication of effort, and promote understanding of tree breeding.

2. The station completed its portion of the Spokane Pine Damage Committee study and reported its findings at a meeting of the Northwest Scientific Association. The study showed that diameter growth of ponderosa pine had been abnormally reduced in the north Spokane area in contrast to the growth pattern on trees at a distance from the affected district. The growth reduction (a) was found to be located around an area where industrial fumes are created, and (b) was not correlated with variations in rainfall.

3. As another step in the station's program for study of pole blight, plots were established which will test the effect of salvage cutting on further development of pole blight in an affected white pine stand. Marking and measurement of the trees were completed and before the end of the year a timber sale contract for the cutting had been awarded. The University of Idaho, Division of Forest Pathology, and Kaniksu National Forest are working cooperatively on this project.

4. Timber sales contracts were awarded for volumes of timber ranging from 1,570,000 board feet to 1,885,000 board feet on the Coram, Deception Creek, and Priest River Experimental Forests in order to carry out large scale silvicultural experiments. The Coram sale will test several cutting and seedbed preparation methods in the larch-Douglasfir type, and the Deception Creek sale will test two methods of blister rust control. The Priest River sale will serve partly as a demonstration of a cutting practice and partly for testing slash disposal methods in cooperation with the University of Idaho. The Deception Creek contract, which was awarded on competitive bid, set a new high price for western white pine - $41.52 per thousand board feet, including a sale area betterment payment of $3.40.

5. Preliminary results from experiments with slash disposal and seedbed preparation methods in lodgepole pine clear cuttings indicate that bunching slash with a bulldozer slash piler is an effective and cheap method. Machine bunching and burning reduced the fuel rating from H-H (high rate of spread, medium resistance to control) to M-L (medium rate of spread, low resistance to control) or its near equivalent, L-M. The direct costs (machine rental and operator wages) of machine bunching and burning amounted to $9.06 per acre in the experiment — an acceptably low figure. Prescribed broadcast burning cost only $2.06 per acre and reduced the fuel rating to L-M, or L-L, but resulted in much less satisfactory natural regeneration. On the basis of stocking by milacre quadrats, burned surfaces on north slopes were stocked only 12 percent after one growing season in contrast to 74 percent stocking where the mechanical slash buncher had removed slash and scarified the ground surface. On the south slopes, burned surfaces were found to be 35 percent stocked and scarified surfaces, 96 percent.

6. An 11-acre accidental broadcast burn of lodgepole pine slash was successfully direct seeded. Prior to seeding, the burn and surrounding area were baited with thallium sulphate treated sunflower seed by the Fish and Wildlife Service to reduce the rodent population. Lodgepole pine seed was planted by the seed-spotting method early in June when the area became free of snow. In September, at the end of the first growing season, 74 percent of the seed spots contained one or more seedlings, with an average of 3 seedlings per spot. The test demonstrated that the direct seeding method, worked out by the station in previous years, is applicable to the lodgepole pine type. The chief requirements for direct seeding in the Northern Rockies are (1) absence of seed-destroying rodents, (2) absence of vegetational competition, (3) sites which are not subjected to severe drying, such as north slopes and flats, and (4) favorable weather during the first growing season.

Range Research

1. The 18-year-old study of cattle grazing intensity, conducted at Miles City in cooperation with the Montana Agricultural Experiment Station and the Bureau of Animal Industry, was modified and reoriented for indefinite continuation. Plans were made for rotating the heifer offspring back into the experiment and more intensive studies of range vegetation and soils were planned.

2. Additional information on the effects of hauling and trailing cows and calves to summer range was obtained. Cows lost about the same weight whether trailed or hauled. Calves lost 10 pounds per head (6 percent of their ranch weight) by trailing but nothing in a 60-mile haul. Trailing and hauling appeared to have no noticeable effect on summer gains.

3. Research in the control of noxious range plants was continued.

   (a) It was found that sprays of 2,4-D (6,000 to 10,000 ppm.) in water or diesel oil give a complete kill of Wyethia in one season. The oil carriers reduced other vegetation 1.5 percent but increases of 6.5 percent occurred where water-carried sprays were used. Similar tests on tall larkspur were unsuccessful.

   (b) Cooperation in noxious range plant research was extended to include the University of Idaho and the Montana Extension Service. Assistance was given by division personnel in guiding general public interest in goatweed control into the organization of the Western Montana Committee on Weed Control which is now active in stimulating research and control programs.

4. Work in range reseeding during 1950 was primarily confined to extending species adaptation studies and developing grazing trials of reseeded species. Three new forage species adaptation nurseries were established, two in northeastern Washington and one on the Fort Missoula area. Two series of pastures were laid out and seeded to improved forage species for future use in determining grazing values of reseeding species.

5. Extension activities were prominent in 1950. More than 500 visitors in 15 organized groups were conducted on show-me tours of cattle grazing experiments and other range phases of the research program at the United States Range Livestock Experiment Station during the year. Division personnel participated as instructors at two range schools, one conducted for college credit by Montana State College, the other mainly for federal agency personnel at the University of Idaho.

Forest Utilization Service

Our Forest Utilization Service worked closely with industrial concerns and other groups throughout the year and assisted in achieving the following:

1. Satisfactory wall board was produced by a local company from pole shaving waste on a pilot plant scale. The board that was developed has strength comparable to other fiber boards and has high decorative properties. It can also be used as a sheeting or plaster base.

2. Development of wood sugar molasses as a livestock feed progressed beyond the experimental stage. In cooperation with Montana State College and livestock feed producers of the State of Montana, a plan was developed for (1) Montana feed dealers to process 500,000 tons of feed using wood sugar molasses as a carbohydrate substitute, and (2) Montana stockmen to feed this material to cattle and sheep under actual range conditions.

3. We cooperated with Montana State College in testing lignin as a soil conditioner in greenhouse soils. Tests showed a 25 percent increase in the weight of blooms on chrysanthemum plants grown on soil to which lignin had been added.

4. Three sawmill demonstrations, attended by 150 operators of small sawmill equipment and other interested individuals, were staged in western Montana in an effort to increase the quality of lumber produced.

5. Arrangements were made for Swiss contractors to test the Wyssen cable logging equipment on an Engelmann spruce operation in the Flathead National Forest in an effort to develop better methods for logging difficult terrain.

6. Inaugurated the successful use of sawdust as a soil conditioner on irrigated sugar beet lands of the Bitterroot Valley, resulting in improvement of the physical condition of the soil and higher sugar content of the beets.

7. Developed the annual program for the Northwest Wood Products Clinic on the subject of associated species. This program directed nation-wide attention to the properties and characteristics of lumber produced from lodgepole pine, larch, white-fir, and species other than ponderosa pine and Idaho white pine.

Forest Economics

Forest Survey, initial phase

1. A plan for carrying on the survey in South Idaho was prepared

and is ready to be used when funds are available. The plan calls for work to be initiated in four counties: Bannock, Bonneville, Madison, and Teton. In these counties various methods for sampling and making type maps to meet forest survey standards are to be investigated.

2. In eastern Montana, where field work was completed in 1949, the last of the unit statistical reports was released as Station Paper 23. This report, "Forest Resources of South Central Montana," gave forest area and timber volume statistics for nine south central counties.

3. A comprehensive statistical report, "Montana Forest Resource and Industry Statistics," was released as Station Paper 25. This summarized the pertinent forest resource and industry data collected by the forest survey in Montana for the past 15 years. The report included a state-wide colored map showing the major forest types.

4. A draft of a forest survey analytical report for the State of Montana was submitted to a board of review. This report includes state-wide data on the timber resource and analyzes the data from the standpoint of the impact of the present resource situation and forest practices on the future of the forest productivity. It points out possibilities for expanding forest industries and what is needed in terms of a development program to maximize timber yields.

Forest Survey, resurvey phase

1. Field inventory and computation of data for the North Idaho resurvey continued during the year. Field work was centered in Idaho County and office work included all counties. About one-half million acres of forest land remains to be covered to complete field work for the resurvey in North Idaho.

2. Industry surveys covering commodity production and timber drain were made for poles, pulpwood, and Christmas trees. These surveys showed the following:

	Commodity production 1948	1949	Percent change
Poles (no. pieces)	447,986	599,312	+ 34
Pulpwood (no. cords)	88,530	113,570	+ 28
Christmas trees (no. trees)	3,098,886	3,256,956	+ 5

Economics of Forest Management, Utilization, and Marketing

1. The study of Christmas tree marketing problems in Montana was completed with the publication of "Marketing Montana Christmas Trees." The bulletin, one of a series being published by the Forestry School, Montana State University, is a comprehensive treatise on

the Christmas tree industry marketing situation. It points out that unless aggressive corrective measures are taken by the industry markets for Montana, trees are likely to decline in the period ahead. Adoption of grading rules, strengthening of grower associations, and trade promotion are recommended.

2. A project analyzing the feasibility of a pulpmill industry in eastern Montana was initiated. This project will include study of the extent and location of the timber resource in eastern Montana, representative manufacturing locations, pulpwood transportation problems, suitability of the timber, relation of a pulpmill industry to other industries, the effect of the ownership pattern on timber use, and the allowable cut of timber products.

Forest Fire Research

Fire Behavior

1. A complete outline for a publication to be entitled "Fire Behavior in Northern Rocky Mountain Forests" was prepared and sent to a board of review. A large amount of data and background material were collected.

2. An experimental model of a rate-of-spread computer was designed, and several were field tested on ranger districts on various national forests.

3. Five fire behavior schools were conducted in cooperation with the Regional Division of Fire Control. These schools were attended by one or more representatives from each ranger district in the region and by all smokejumpers. A series of lantern projection slides illustrating pertinent features of fire behavior were prepared for use in these schools.

4. Analysis of some 22,000 Forest Service fire reports indicated the need for a revision of the fuel rate-of-spread classification to better indicate the danger in flashy fuels such as grass and continuous fine fuels found in some logging slash areas. Accordingly, recommendations were prepared for a new classification system involving five rather than four rate-of-spread types. In addition some tentative fuel classification keys were prepared to simplify identification of the various types.

Fire Danger Rating

1. Studies of large log fuel moisture and condition of herbaceous vegetation were continued at the Priest River Experimental Forest. At the end of the year an analysis of data collected to date from the large log experiments was begun. The results of these studies will be used to improve the rating of seasonal fire danger build-up.

2. Fuel moisture stick manufacture was continued at Priest River. Some 2,000 sets of sticks were manufactured during the summer for use by all forest protection agencies in the western United States.

3. The annual rating of the 1950 fire season was prepared, and in addition a summary of fire danger rating for the past 17 years was compiled. The 1950 season was the second easiest on record.

Fire Control

1. An analysis of 36,000 forest fire reports was completed. A manuscript, now in final form, entitled "Forest Fires in the Northern Rocky Mountains," will be issued in 1951.

2. During 1950 a comprehensive analysis was made of the combined air-ground detection systems now being operated on several national forests. This analysis provided information regarding the efficiency of patrol aircraft and lookouts as well as other data required in detection planning.

3. An analysis was completed of all fires receiving smokejumper action during the period 1940-1949. Maps were prepared showing the location of all smokejumper fires. This analysis should provide valuable background material for future work in fire control planning research.

4. Cooperation was continued with the University of Idaho and the Division of Forest Management Research in slash disposal studies. Basic data on slash fires were provided workers on the University of Idaho project.

Flood Control Surveys

1. Cover type and condition data, from the standpoint of watershed characteristics, were compiled for four of seven tributary areas for which hydrological and economic analyses are to be made. Forest Survey information, used as a base, was reclassified and supplemented by data on ground cover, slope, elevation, litter, humus, use, and other factors.

2. A reconnaissance type of soil survey was made on the four watersheds mentioned above. Geological formation and physiography were the two most important criteria for classification. Emphasis was on factors relfecting soil-water relationships. Classification was difficult because the soils are young and undeveloped geologically, and because of the absence of secondary sources of information. Areas of glacial action presented special problems.

3. Collection of flood damage data was started. Most of the effort was in securing and reviewing secondary sources, particularly files of the Corps of Engineers. Progress has been made in

3. obtaining information on damage to national forest lands and improvements.

4. Flood Control Surveys personnel have worked aggressively with regional men in describing projects and measures, preparing standards and objectives, and determining costs and man-day requirements for flood control plans and Columbia Comprehensive Plan purposes.

5. Snow studies at the Priest River Experimental Forest were continued with some modifications. Field work was completed on the altitude-aspect plots; preliminary figures reflect differences in snow conditions by elevational zones and direction of exposure. One year's record was completed on comparison of precipitation catches in four types of measuring gages installed on wind-swept sites. Results are being prepared for publication. The Benton Spring installation was improved so that a continous flow record is now being obtained. The installation of about 90 soil moisture-temperature units was completed in the early part of the year. These are located at various soil depths in seven different locations.

6. Unusual snow conditions prior to the melt season led to snow-melt studies in three mountain-top areas. Known as "Operation Snow Pack," this work was undertaken in an effort to gain additional information on snow behavior under various cover, aspect, and weather conditions. Melt conditions were such that the anticipated high water or flood runoff did not develop. A report is being prepared.

7. In cooperation with the Region, the Division received late-season readings on 25 or 30 regular cooperative snow courses. The readings were taken at 2-week intervals from time of maximum accumulation until melting was complete. In addition to the above, a few low-elevation courses and courses in brush areas were established and measured.

Wildlife Research
(In cooperation with the Fish and Wildlife Service)

1. Certain phases of a 4-year study of deer in relation to ponderosa pine plantations was completed on the Kootenai National Forest. Among findings to be published soon is the outstanding fact that in 3 years deer destroyed nearly 40 percent of the trees planted on 7 experimental plots.

2. A study of the consumption of ponderosa pine seed by small mammals showed that white-footed mice and chipmunks eat large numbers of pine seed. An abundant natural crop of seed was reduced by the rodents to a level which was inadequate for restocking the cut-over area.

3. Three contributions were made to the Wildlife literature on statistical methods. Papers were published on a punch-card technique for handling wildlife data and on the use of biometry in wildlife research. A manuscript was completed on confidence limits for the Lincoln Index, a technique for wildlife inventory.

Forest Pathology Research
(In cooperation with the Division of Forest Pathology)

Pole blight research has been underway about two years. Early results during 1950 were:

1. A manuscript was completed summarizing the early results of Scopularia inoculations on white pine. After one year, inoculated trees showed lesions with associated resinosis resembling those on pole blighted trees but no foliage or crown deterioration. Additional inoculations of Scopularia on tree species associated with white pine have been made.

2. The initial pole blight survey and mapping job was completed in the region except for the Cabinet National Forest.

3. Further tests of the effects offertilisers on pole blighted stands were established.

FILE COPY
FORTY FIRST ANNUAL REPORT
- Northern -
Rocky Mountain
Forest & Range
Experiment Station
Missoula, Montana
George M. Jemison, Director
UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE